Natural Bridges
National Monument

National Park Service
Department of the Interior

International Dark-Sky Park Designation (Gold Tier)

Natural Bridges National Monument Nomination Package

Photo: Wally Pacholka / AstroPics.com

A proposal to the

International Dark-Sky Association

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1. Letter of Nomination

IDA Board of Directors
International Dark-Sky Association
3225 North First Avenue
Tucson, Arizona 85719-2103

Date: 2/16/2007

Dear IDA Board of Directors,

I would like to nominate Natural Bridges National Monument in southeast Utah for Dark-Sky Park (Gold Tier) status from the International Dark-Sky Association. I have been the Chief Ranger at Natural Bridges for five years and a member of IDA for two years. One of the pleasures of working in this very remote park is that it hosts unbelievable night sky vistas. The monument has virtually no light pollution from surrounding areas and is committed to good lightscape management.

The visual appearance of the sky from the monument is stunning; Natural Bridges has the darkest sky measured by the NPS Night Sky Team. There are no primary sources of light pollution to affect our sky. The only light sources are secondary light sources, which are the Cortez, Colorado, and Shiprock, New Mexico, area to the Southeast and the town of Kayenta, Arizona, to the Southwest. The only significant light sources in the park are the park housing, maintenance yard, and visitor center lights. These light sources do not have a large impact on the sky and the park has worked very hard to moderate these necessary light sources. The appearance to the naked eye of the Scorpius Milky Way easily fit Bortle's description for Class 2 with intricate detail resembling veined marble, and the sky being quite dark to within 15 degrees of the horizon in all directions. With these conditions a limiting magnitude of 7.1 or greater and a Bortle Class of 2 are reliably measured at Natural Bridges. This is a very dark and pristine sky worthy of aggressive protection and promotion. The Natural Bridges Dark-Sky Park should be designated at the "Gold" level.

Over the last year we have been working closely with the NPS Night Sky team based in Bryce Canyon National Park to reduce the Light pollution from our park and to improve the nighttime scene. In the summer of 2006 the NPS Night Sky Team were able to provide Natural Bridges with fully shielded lights to install on all the buildings of the park. The park has a total of 52 outdoor lights on the visitor center, maintenance buildings and residential buildings. Of these we have replaced 36 lights with Glarebusters with 13 watt compact fluorescent lamps. A few lights are on order and other lights will be removed. All light will comply with the park guide lines. These lights provide the minimum illumination necessary for safety and are consistent with the dark ambient environment.

April 16, 2008 will mark 100 years since the National Monument designation. Since it was the first Park Service area established in the state of Utah and one of the first Parks established through the Antiquities Act, there is cause for celebration. What a great centennial it would be if we could also celebrate being the first National Park Service site awarded International Dark Sky Park status as well.

Sincerely,

/s/ *Ralph Jones*

Ralph Jones
HC 60 Box 1
Lake Powell Utah 84533
435-692-1234 x13
Ralph_Jones@nps.gov
www.nps.gov/nabr

2. Superintendent Letter of Support

United States Department of the Interior

NATIONAL PARK SERVICE
Natural Bridges National Monument
Hovenweep National Monument
HC 60 Box 1, Lake Powell, Utah 84533
435-692-1234

Date: 2/16/2007

IDA Board of Directors
International Dark-Sky Association
3225 North First Avenue
Tucson, Arizona 85719-2103

Dear IDA Board of Directors:

As the superintendent of Natural Bridges National Monument, I strongly support this nomination for Dark-Sky Park designation. Our park possesses one of the most amazing astronomical displays in southeastern Utah, if not the entire United States. Due to its isolated location far from towns and other sources of light pollution and surrounded on three sides by plateaus, the monument's night skies have remained pristine.

The Organic Act of 1916 directs the NPS to protect three primary resources—historic and cultural objects, plant and animal life, and scenery. While scenery has been traditionally thought of as being geologic curiosities, distant vistas, and sublime landscapes, it also includes the night sky. Standing at one of the park's many prehistoric archeological sites, one can easily imagine another human centuries earlier gazing awestruck into the same universe while surrounded by ecosystems that have adapted to the natural rhythms of the moon and stars.

As over-lit skies become the norm, the public is seeking star-filled skies. Visitors are pleasantly surprised to experience the beauty of the night at Natural Bridges—perhaps never having witnessed before an unfettered view of a starry sky. Here visitors can enjoy stargazing through telescopes, walking in a natural nighttime scene, or camping beneath the stars. Park staff and volunteers not only connect visitors to the plants, animals and geology of a park, they can promote and guide them through the night sky as well.

Unspoiled natural lightscapes have natural, cultural, and scenic importance, and the NPS is charged with their protection. The staff of Natural Bridges NM takes this responsibility very seriously. During the past two years, all stationary lights in the monument were inventoried, analyzed, and either eliminated or replaced with fully shielded lighting devices. In appropriate areas around the visitor center and in the maintenance yard and housing area, a few key fixtures were fitted with motion activated lights placed on timers to supply lighting only as needed. The entire park staff is personally committed to maintain lightscapes as an important element of the park environment.

Reviewing the positive changes made in the last few years to insure maintaining an exceptional dark sky, verifies the commitment of the park. Natural Bridges National Monument is a prime candidate for your Dark-Sky Park designation. Please give this nomination your up most consideration.

Sincerely,

/s/ Coralee Hays

Coralee S. Hays. Superintendent
HC 60 Box 1
Lake Powell Utah 84533
435-692-1234 x15
Corky_Hays@nps.gov

3. IDA Members Letters of Support

United States Naval Observatory
Flagstaff Station
World Premier Site for Stellar Positions and Distances
10391 West Naval Observatory Road
Flagstaff Arizona 86001

International Dark-Sky Association
3221 North First Ave.
Tucson, AZ 85719

Date: 2/16/2007

Ralph Jones, chief ranger at Natural Bridges National Monument, was the impetus for the development of the IDA's new Dark Sky Park program when he approached IDA last year with the idea and his goal of having Natural Bridges National Monument be the first such park. A committee was formed to develop the criteria for this program, building on the IDA Dark Sky Community program developed in 2001. Mr. Jones contributed constructively to the development of these criteria, and has worked diligently to assure that Natural Bridges NM achieved and exceeded the criteria.

It is with great pleasure that I lend my enthusiastic support for the nomination of Natural Bridges National Monument to be the first IDA Dark Sky Park.

Sincerely,

/s/ CHRISTIAN B. LUGINBUHL

Christian B. Luginbuhl

NIGHT SKY GALLERY
IMAGING THE SKIES OF AMERICA'S PARKS
5733 LANAI STREET, LONG BEACH, CALIFORNIA 90808
TEL: 562-397-0591 Fax: 562-268-4291

International Dark-Sky Association
3225 N First Ave
Tucson, AZ 85719

February 16, 2007

Dear IDA Management,

This letter is to give my nomination and support to Natural Bridges National Monument as a "Dark-Sky Park" qualified park. I have not only reviewed the proposal by Chief Ranger Ralph Jones but have been to Natural Bridges National Monument and it's surrounding area on numerous occasions and can attest that this park more than meets your minimum requirements with it's pristine dark skies (one of the best in America) and it's superb management of lighting and energy. It is without question one of the darkest sites I have come across in the American Southwest.

As an amateur astronomer, IDA member, and photographer, I have been on a quest over the last 4 years to document with my astro-photography the incredible night skies over America's Southwestern Parks showing the amazing scenic landscapes with equally amazing night skyscapes over so many of our National Parks and Monuments. In my work, I travel extensively throughout the American Southwest hiking the park trails by day and by night. Last year alone, I traveled from my base in light polluted Long Beach, California to all of the Grand Circle of national parks and monuments in Utah, Arizona and New Mexico three times to image the continuous parade of celestial events over these parks. Natural Bridges is certainly the darkest site I have come across and is worthy to receive your "Dark-Sky Park" qualification not only due to it's location, but due to it's management's commitment to visitor night sky interpretation, efficient lighting, energy and natural resources to maintain a pristine environment in viewing the night sky. You have here the opportunity to create your poster child "Dark-Sky Park". You will not find a better-qualified park.

Should you need any further clarification or have further questions, please do not hesitate to call me at 1-888-811-1950 or email at wally@AstroPics.com.

Sincerely,

/s/ *Wally Pacholka*
Wally Pacholka

4. Park Information and History

Natural Bridges National Monument preserves some of the finest examples of natural stone architecture in the southwest. A tree-covered mesa next to deep sandstone canyons, the location for three natural bridges to form when the meandering streams slowly cut through the rising Colorado Plateau and the canyon walls. First named for explorer's families, in honor of the Native Americans that made their homes here, the bridges are now named Kachina, Owachomo and Sipapu.

The Monument is located in beautiful southeastern Utah and is home to three massive natural stone bridges nestled quietly in our canyons. The monument is surrounded by a ridge line that tops off at 9,000 feet with Ponderosa Pine, Aspen and Douglas Fir. Natural Bridges is in the heart of the Colorado Plateau which offers endless outdoor activities such as biking, hiking, backpacking, climbing, camping, and many more. Weather is genuinely good throughout the year, while winter can bring significant amounts of snowfall. Considered remote, Natural Bridges is located 40 miles from the small town of Blanding. The monument is surrounded by millions of acres of federal protected land including sites managed by the Bureau of Land Management, National Park Service, and US National Forest.

A paved, 9-mile loop road provides access to overlooks and trailheads for the three massive natural bridges. Each bridge can be viewed by walking a short distance to an overlook. Trails descend to the canyon bottom to view each bridge. Along the canyon bottom and on the mesa top trails connect the bridges and trailheads and offer loop hikes of varied lengths. Natural Bridges National Monument is open seven days a week all year round. The visitor center is open 8:00am to 4:30 pm and has exhibits and an orientation video. Archaeological sites can also be viewed from overlooks along the rim or hikes in the canyons. A 13-site campground has tables, tent pads, grills, and pit toilets with a fantastic view of the night sky.

Historically, in 1883 prospector Cass Hite wandered up White Canyon from his base camp along the Colorado River. In search of gold, he found instead three magnificent bridges that water had sculpted from stone. In 1904 National Geographic Magazine publicized the bridges, and in 1908 President Theodore Roosevelt established Natural Bridges National Monument, creating Utah's first National Park System area.

From the 1904 National Geographic Magazine:

> "Remounting their horses, Long and Scorup passed under the mighty mass of the Caroline (now Kachina Bridge) and pushed on up the canyon. At a distance of three and a half miles they found themselves in the presence of what is doubtless the most wonderful natural bridge in the world – a structure so lofty and magnificent, so symmetrical and beautiful in its proportions, as to suggest that nature, after completing the mighty structure of the Caroline, had trained herself for a finer and nobler form of architecture." (now Sipapu Bridge)

Sipapu Bridge

Sipapu is the largest and most spectacular of the three bridges in the Monument. It is considered middle aged, older than Kachina but younger than Owachomo. It's rounded opening and smooth sides are mute evidence of countless floods bearing scouring rocks and sand. This bridge, whose opening would almost house the dome of the United States Capitol, has taken thousands of years to form but will someday collapse and erode as part of the endless cycles of time and change.

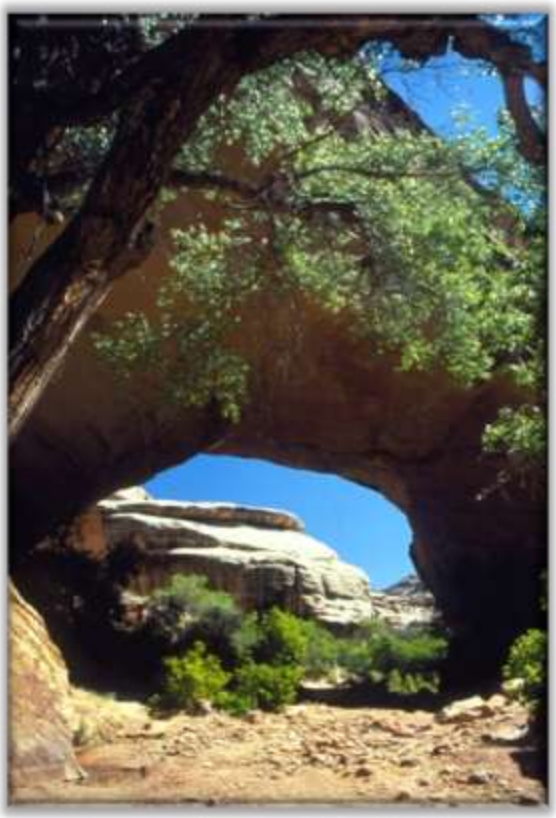
The Paiute referred to all bridges as mah-vah-tak-tump, translated today as under the horse's belly. While today we refer to this bridge as Sipapu, has been known by several names in the last 100 years, President: this name was applied by Cass Hite in 1883. Hite operated a placer gold mine on the Colorado River and explored White Canyon from there. Augusta: Horace Long, who explored the region in 1904, renamed the bridge after his wife. Sipapu: A Hopi term for the opening between worlds, the present name was given by William Douglas, who led a government survey party to the bridges in 1908, mapping the exact boundaries of the new national monument. Douglas thought that the ruins and rock art found in the area must be related to the Hopi people of northern Arizona.

Dimensions (feet/meters)

- Height: 220/67
- Span: 268/82
- Width: 31/9.5
- Thickness: 53/16

Kachina Bridge:

Kachina is "the middle bridge." Spanning the canyon equidistant from both Owachomo and Sipapu bridges. It is larger than Owachomo but smaller than Sipapu. Proving that canyons are dynamic rather than static, approximately 4,000 tons of sandstone fell from the inside of the Kachina bridge opening in June, 1992, enlarging the opening as it has doubtless been enlarged time and time again.



Government surveyor William Douglas dubbed the bridge "Kachina" when he found petroglyphs and pictographs depicting dancing figures carved on the base of the bridge. Douglas assumed that the ancestral Pueblo people who left the ancient rock art were related to the present day Hopi people, and that the painted and carved figures represented Kachina dancers. Before Douglas, local cowboy Jim Scorup named the bridge "Caroline" in honor of his mother. Before that, Cass Hite had named it "Senator."

Dimensions (feet/meters)

- Height: 210/64
- Span: 204/62
- Width: 44/13
- Thickness: 93/28

Owachomo Bridge

Owachomo is the smallest and thinnest of the three natural bridges here and is commonly thought to be the oldest. We may never know for certain, as each of the bridges certainly has eroded at different rates. Regardless of its relative age, it is certainly the most fragile and elegant of the three spans, and an awe inspiring feature of erosion.

Owachomo means "rock mound" in Hopi and is named after the rock formation on top of the east end of the bridge. Before William Douglas gave it this name in 1908, it was called "Edwin" or "Little" bridge. Prior to that, it was referred to as "Congressman" by miner and explorer Cass Hite.

Early in the Monument's development, a dirt road led to Owachomo bridge from the south. It ended at the campground and ranger station directly southwest of the bridge. There were no other roads, and visitors seeking the other two bridges hiked or rode horses through the rugged canyons, often guided by the first "custodian" of the National Monument, Ezekiel "Zeke" Johnson. Today, remnants of "Zeke's trail", now on the National Register of Historic Places, can still be seen just across the canyon below Owachomo.

Dimensions (feet/meters)

- Height: 106/32
- Span: 180/55
- Width: 27/8
- Thickness: 9/3

Solar Powered Park

Electricity at Natural Bridges National Monument is produced from a photovoltaic system installed in June 1980. The PV array produces up to 50 kilowatts of power. That is more than enough electricity to supply the needs of the small community of National Park Service personnel, their families and the public.

The PV array is located on an acre of land across the road from the visitor center. A short path from the west side of the visitor center parking area leads to a viewing platform. Here, with a push of a button, an audio message explains the photovoltaic process.

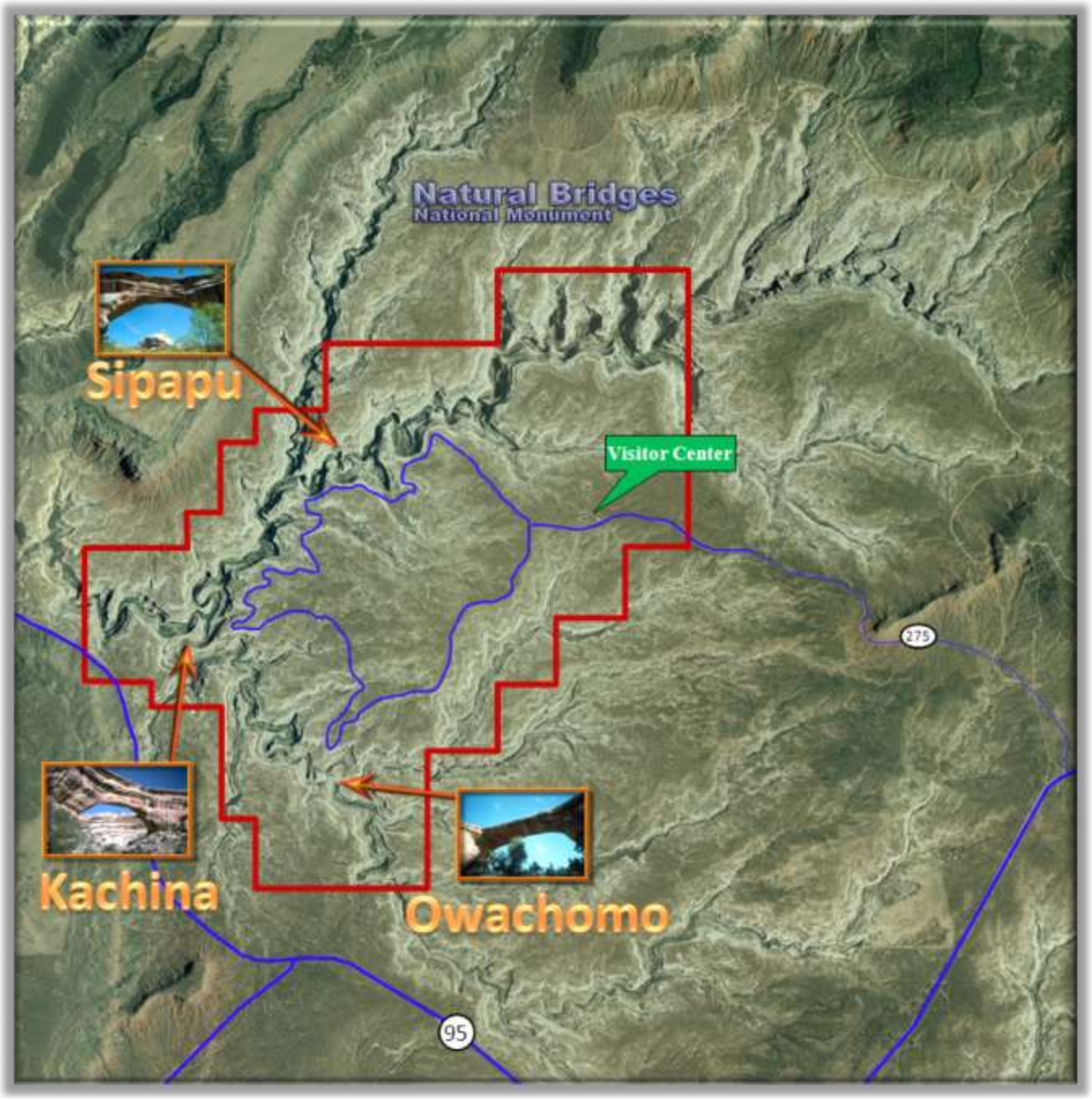
Natural Bridges National Monument was chosen as a demonstration site for the use of solar energy more than two decades ago. Situated at an elevation of 6500 feet in Utah's southeastern desert, Natural Bridges' moderate, sunny climate makes it an ideal location for a solar energy system. Other factors in this decision included Natural Bridges' remote location away from commercial power sources and the solar system's accessibility to the visiting public.

The high cost per kilowatt-hour for electricity makes energy efficient outdoor lighting even more important in this setting.

For More Park Information: www.nps.gov/nabr

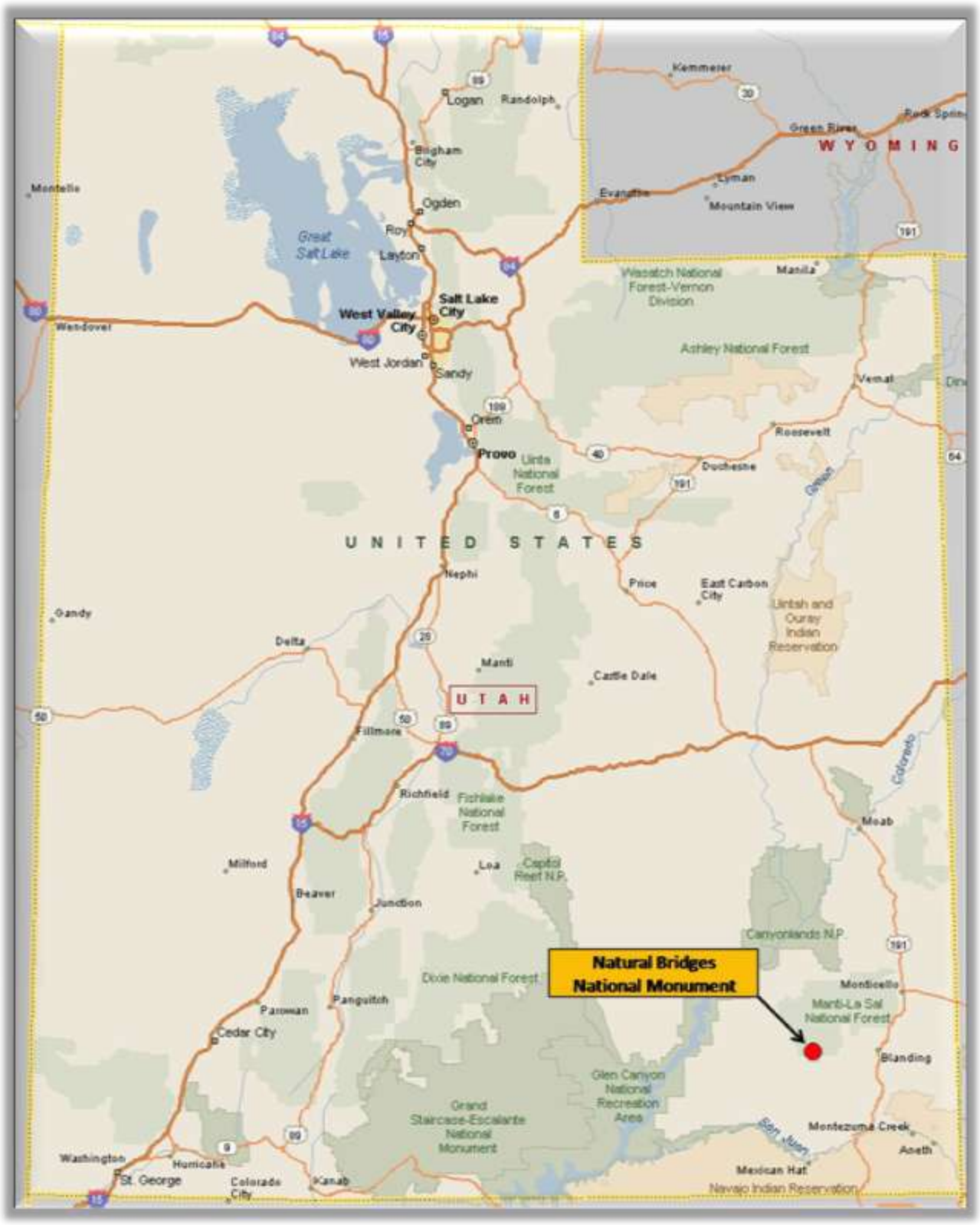
5. Map of Area to be Designated

This nomination is to include the entire area of Natural Bridges National Monument (7500 acres). This area is marked below as all areas within the red outline that marks the bounder of the monument. The entire park is open to night viewing. Visitors may do night sky watching on the loop drive, hiking trails and all overlooks. For overnight camping people must stay in the campground.



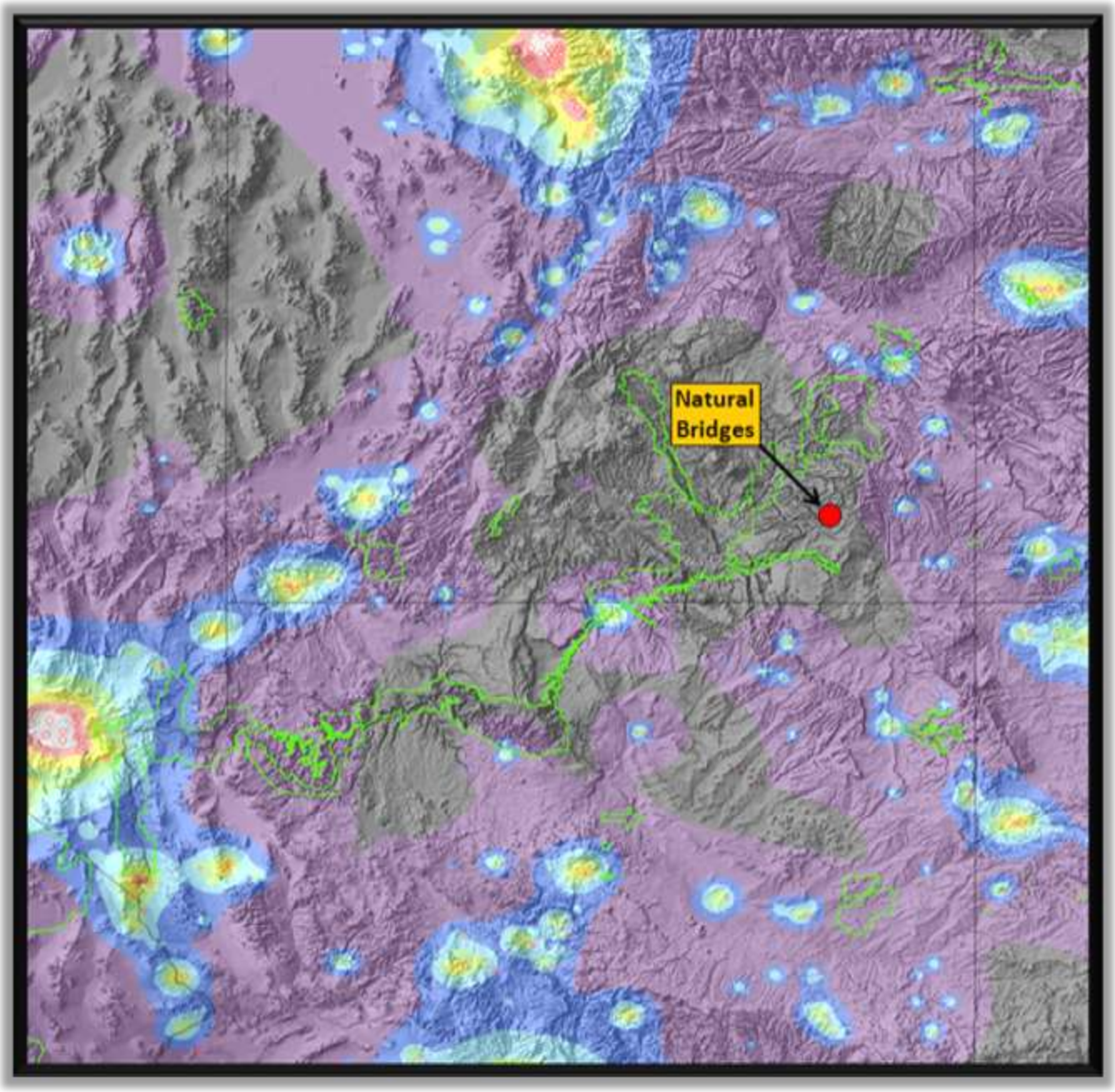
6. Location of Natural Bridges National Monument

Natural Bridges is located in the southeast corner of Utah at the end of Highway 275. This is roughly 40 miles west of Blanding, Utah off Highway 95. It is 45 miles north of Mexican Hat, Utah. It is about 4 hours north east of Flagstaff, Arizona.



7. Documents of Sky Quality

a) Map of Light Intensity for the Colorado Plateau

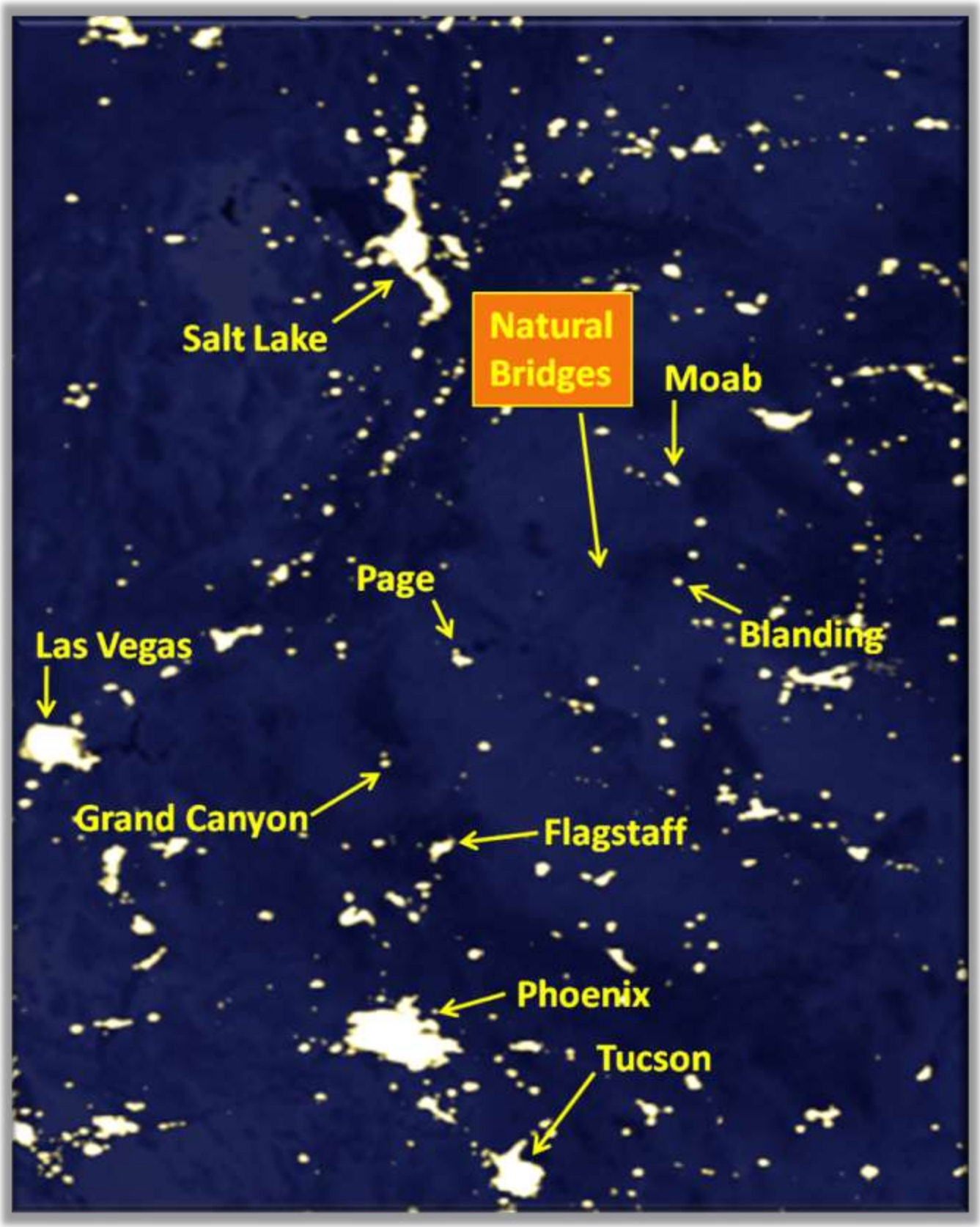


Colorado Plateau Night Skies

Cinzano Model:
First World Atlas of Artificial Night Sky Brightness

Light flux sources on the Colorado Plateau based on DMSP satellite data and computed effects on the night sky, modeling the light propagation in the atmosphere

b) NOAA Map of Utah & Arizona Light Sources.



NOAA DMSP Satellite Image showing light sources in the areas around National Bridges National Monument

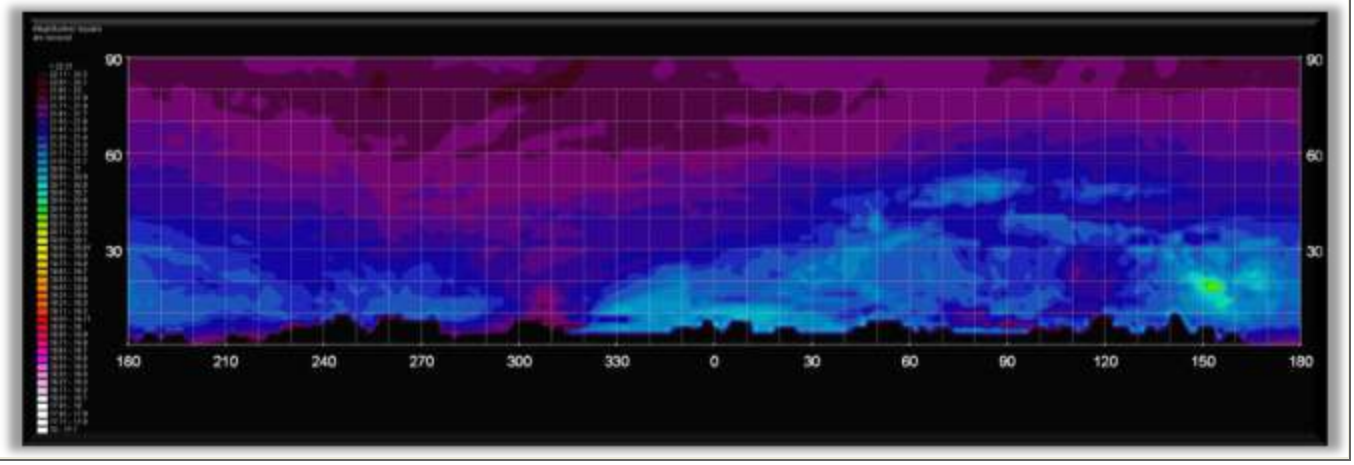
c) Night Sky Quality Monitoring Report – From NPS Night Sky Team

Natural Bridges NM, Utah - Loop Drive Intersection, June 4, 2003

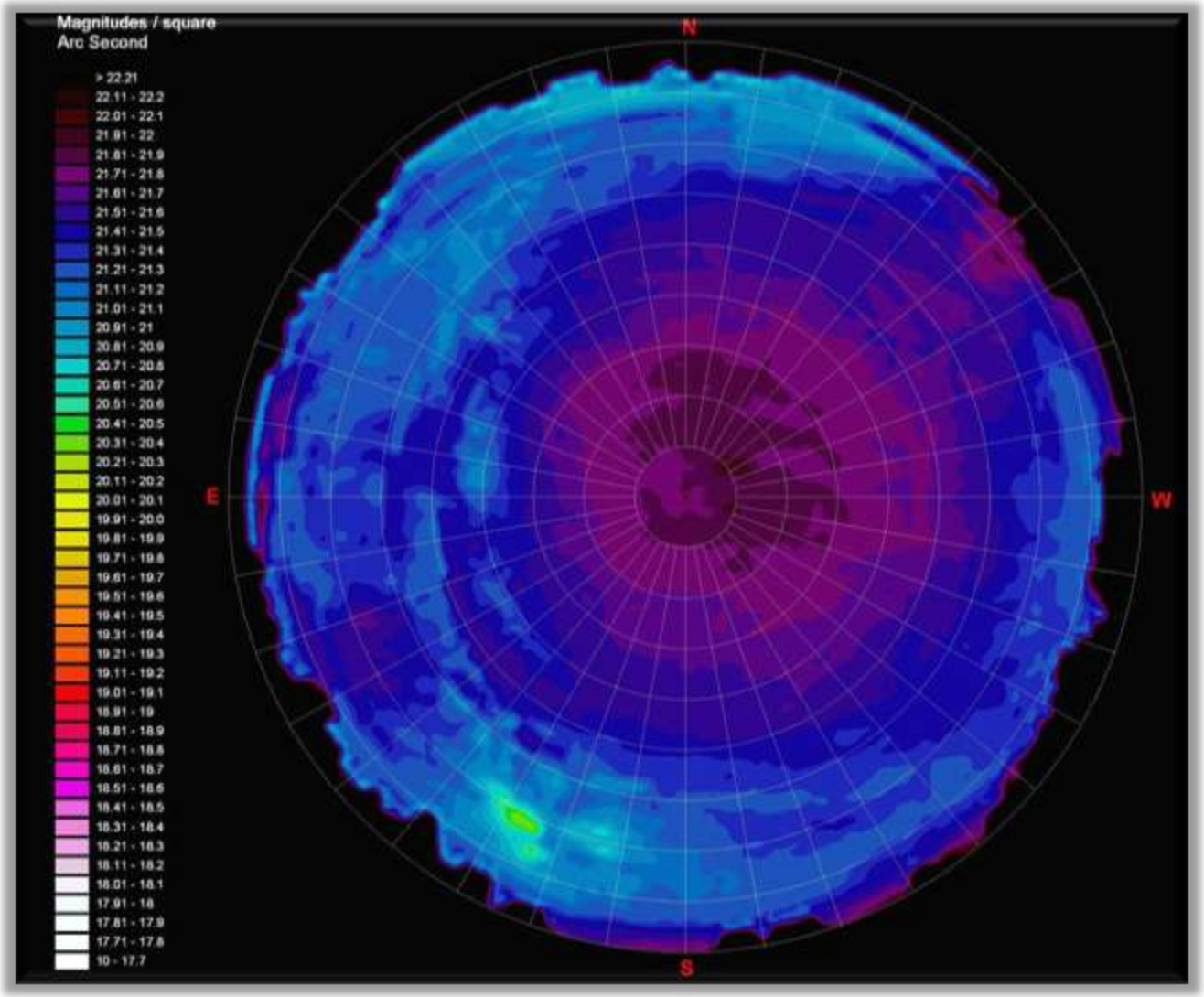
To effectively manage any resource, we need to know what we have and what we've lost. "Light Pollution", the brightness in the nighttime sky due to artificial light, can be seen from almost every park. The NPS has developed a system for measuring sky brightness to quantify the source and severity of light pollution. This system, developed with the assistance from professional astronomers and the International Dark-sky Association, utilizes a research-grade digital camera to capture the entire sky with a series of images. Data clearly shows that even remote national parks are not immune from stray artificial light. Sky brightness is measured in astronomical magnitudes in the V-band, abbreviated as "mags". The V-band measures mostly green light, omitting purple through ultraviolet and orange through infrared. The magnitude scale is a logarithmic scale. A difference of 5 magnitudes corresponds to a 100x difference in brightness. Lower values (smaller or more negative) are brighter. Data images are shown in false color, with yellow, red, and white corresponding to brighter sky and blue, purple and black corresponding to darker sky.

SKY BRIGHTNESS DATA								
Data Set Number	**Time (UT)**	**Extinction Coefficient** (mag/air-mass)	**Std Err Y Extinction Stars** (mags)	**Zenith** (mag/sq arc-sec)	**Whole Sky** (mags)	**Sky Above 20° Altitude** (mags)	**Brightest** (mag/sq arc-sec)	**Darkest** (mag/sq arc-sec)
1-Start	6:39:30							
End	7:07:26	0.160	0.088		-7.03	-6.54	20.35	21.95

LIGHT DOME DATA			
City	**Distance (km)**	**Azimuth**	**1st Data Set Brightness (mags)**
Total			-.34



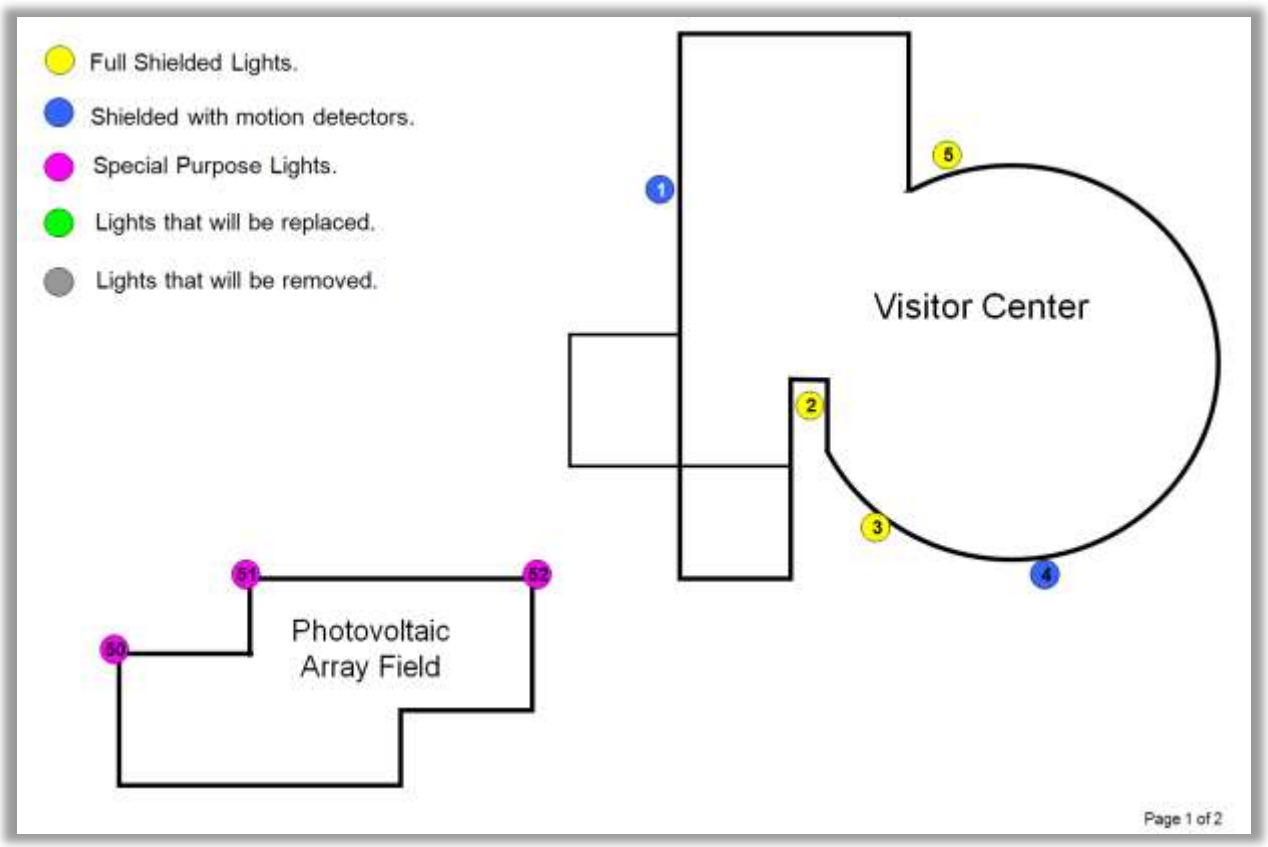
Category	Details	Category	Details
Park	NABR	**Observers**	D. Duriscoe, C. Duriscoe
Site Name	Loop Drive Intersection	**Air Temp (°F)**	
Longitude	-109.98653	**Rel. Humid (%)**	
Latitude	37.6087	**Wind Sp (mph)**	-
Elevation (m)	1975	**CCD Temp (°C)**	-25
Date (UT)	June 4, 2003	**Exp (seconds)**	8
Time Start (UT)	6:39:30	**Bortle Class**	2
Data Quality	Fair	**ZLM**	7.1
Equipment	Apogee, 35mm f/2, Bessel V		

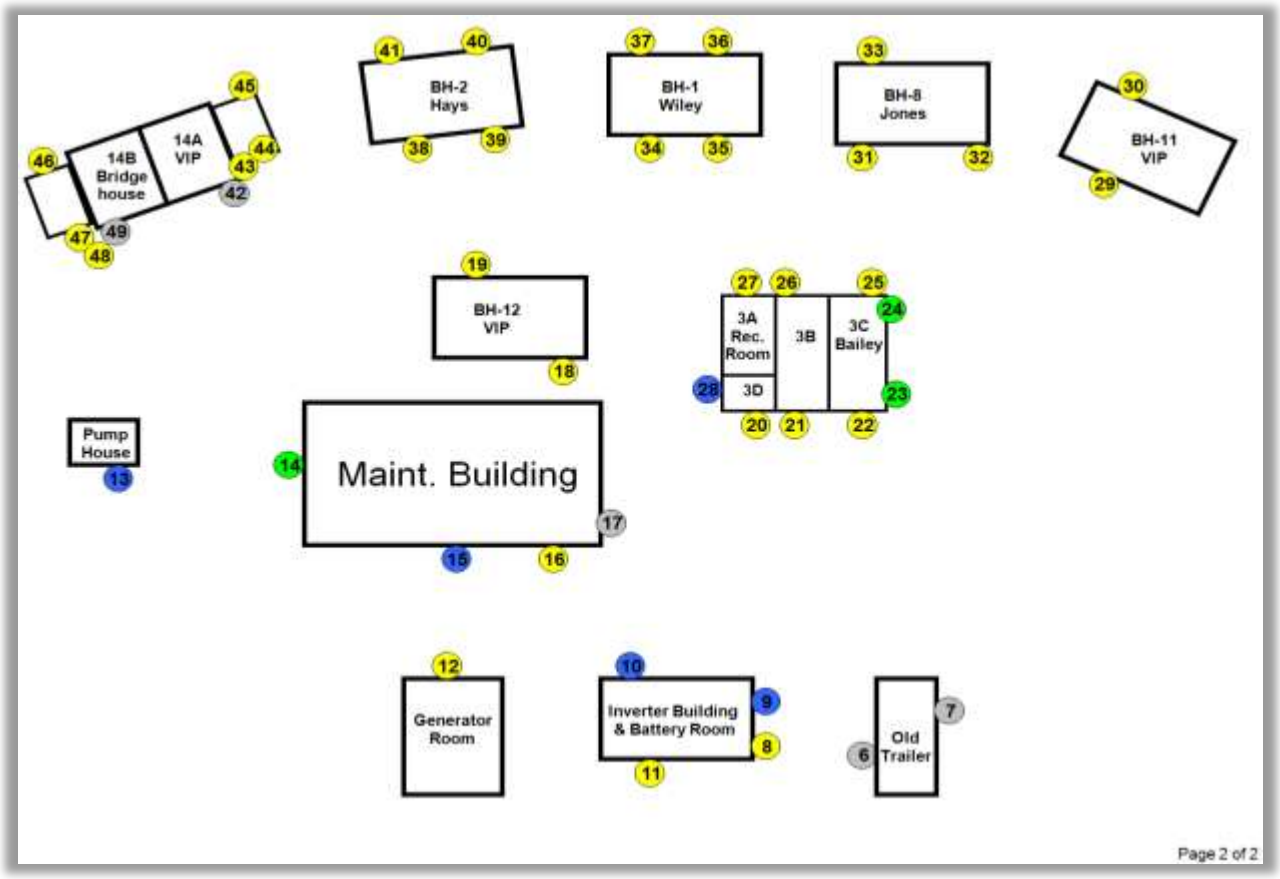


Narrative: The ONLY Bortle class 2 sky seen to date, no evidence of light domes from cities anywhere along the horizon. Horizons somewhat blocked to east, north, and west, however. Nevertheless, incredible detail in Milky Way, numerous dust lanes visible in Scorpius and Ophiucus. A lot of fire smoke drifting through confuses extinction measures, poor regression, and affects sky brightness measures somewhat. Transparency good, seeing well, warm, no wind.

6. Park Light Inventory

a) Map of All Lighting in Monument





b) Light Inventory Matrix

Natural Bridges National Monument – Light Inventory

Location	Light Ref. #	Photo	Fixture	Application	Fully-Shielded	Special Purpose <1000 lumens	Conformity with Lighting Guidelines
Visitor Center	1		Glarebuster, 13 Watt Compact Fluorescent with Motion Detector	Back door to Visitor Center	YES	NO	YES
	2		4 – 24 Watt Fluorescent Tubes	Restroom Entrance	YES	YES	YES
	3		Glarebuster, 13 Watt Compact Fluorescent	Visitor Center Front Door – Light used at night.	YES	NO	YES
	4		Glarebuster, 13 Watt Compact Fluorescent with Motion Detector	Visitor Center Sign Light.	YES	NO	YES
	5		Glarebuster, 13 Watt Compact Fluorescent	Visitor Center Back door.	YES	YES	YES
Old Trailer	6		Old light unused light without electricity.	No Application – Light not used.	NO	NO	NO – - This trailer will be taken down & light will be removed.
	7		Old light unused light without electricity.	No Application – Light not used.	NO	NO	NO – - This trailer will be taken down & light will be removed.
Photovoltaic Building	8		Wallpack, approx 175 watt	Emergency Lighting for Photovoltaic Battery Room Rarely used < 4 times per year	NO	NO	NO – New Shielded Emergency Battery Backup Power lights are on order.

	9		Glarebuster, 13 Watt Compact Fluorescent with Motion Detector	Lighting outside exercise / weight room.	YES	NO	YES
	10		Glarebuster, 13 Watt Compact Fluorescent with Motion Detector	Outside Photovoltaic Inverter room	YES	NO	YES
	11		I do not know what this light is called? Wallpack, approx 175 watt	Emergency Lighting for Photovoltaic Battery Room Rarely used < 4 times per year	NO	NO	NO – New Shielded Emergency Battery Backup Power lights are on order.
Generator Building	**12**		15 Watt Compact Fluorescent	Lighting for Generator Room	YES	NO	NO – New Shielded Emergency Battery Backup Power lights are on order.
Water Pumphouse	**13**		Glarebuster, 13 Watt Compact Fluorescent with Motion Detector	Water Pump House	YES	NO	YES
Maintenance Building	**14**		15 Watt Compact Fluorescent.	SAR / Fire Cache	NO	NO	NO - This light is not working. Light will be replaced when new fixture is ordered.
	15		Glarebuster, 13 Watt Compact Fluorescent with Motion Detector	Maintenance Building Door	YES	NO	YES
	16		Glarebuster, 13 Watt Compact Fluorescent with Motion Detector	Maintenance Offices Door	YES	NO	YES
	17		Twin PAR with Motion Detector	Maintenance On side of Building	NO	NO	NO This light will be removed.

Residential: BH-12 Volunteer Housing	18		Glarebuster, 13 Watt Compact Fluorescent	Residential lighting at door.	YES	NO	YES
	19		Glarebuster, 13 Watt Compact Fluorescent	Residential lighting at door.	YES	NO	YES
Tri-Plax: Apartment, Recreation Room, Volleyball Court, Laundry Room	20		Glarebuster, 13 Watt Compact Fluorescent	Residential lighting at door.	YES	NO	YES
	21		Glarebuster, 13 Watt Compact Fluorescent	Residential lighting at door.	YES	NO	YES
	22		Glarebuster, 13 Watt Compact Fluorescent	Residential lighting at door.	YES	NO	YES
	23		Halogen Floodlight	Volleyball Court Lighting. Occasional Use.	NO	NO	NO, over 1000 lumens. Park is ordering replacement light.
	24		Halogen Floodlight	Volleyball Court Lighting. Occasional use.	NO	NO	NO, over 1000 lumens. Park is ordering replacement light.
	25		Glarebuster, 13 Watt Compact Fluorescent	Residential lighting at door.	YES	NO	YES
	26		Glarebuster, 13 Watt Compact Fluorescent	Residential lighting at door.	YES	NO	YES

	27		Glarebuster, 13 Watt Compact Fluorescent	Residential lighting at door.	YES	NO	YES
	28		Glarebuster, 13 Watt Compact Fluorescent with Motion Detector	Laundry Room Lighting	YES	NO	YES
Residential: BH-11 Volunteer Housing	**29**		Glarebuster, 13 Watt Compact Fluorescent	Residential lighting at door.	YES	NO	YES
	30		Glarebuster, 13 Watt Compact Fluorescent	Residential lighting at door.	YES	NO	YES
Residential: BH-8, Jones	**31**		Glarebuster, 13 Watt Compact Fluorescent	Residential lighting at door.	YES	NO	YES
	32		Glarebuster, 13 Watt Compact Fluorescent	Residential lighting at garage door.	YES	NO	YES
	33		Glarebuster, 13 Watt Compact Fluorescent	Residential lighting at garage door.	YES	NO	YES
Residential: BH-1, Wiley	**34**		Glarebuster, 13 Watt Compact Fluorescent	Residential lighting at garage door.	YES	NO	YES
	35		Glarebuster, 13 Watt Compact Fluorescent	Residential lighting at garage door.	YES	NO	YES

	36		Glarebuster, 13 Watt Compact Fluorescent	Residential lighting at garage door.	YES	NO	YES
	37		Glarebuster, 13 Watt Compact Fluorescent	Residential lighting at garage door.	YES	NO	YES
Residential: BH-2, Hays	**38**		Glarebuster, 13 Watt Compact Fluorescent	Residential lighting at garage door.	YES	NO	YES
	39		Glarebuster, 13 Watt Compact Fluorescent	Residential lighting at garage door.	YES	NO	YES
	40		Glarebuster, 13 Watt Compact Fluorescent	Residential lighting at garage door.	YES	NO	YES
	41		Glarebuster, 13 Watt Compact Fluorescent	Residential lighting at garage door.	YES	NO	YES
Residential: 14A, Volunteer Housing	**42**		15 Watt Compact Fluorescent	Residential lighting for handicap walkway.	NO	NO	NO This light will be removed.
	43		Glarebuster, 13 Watt Compact Fluorescent	Residential lighting at garage door.	YES	NO	YES
	44		Glarebuster, 13 Watt Compact Fluorescent	Residential lighting at garage door.	YES	NO	YES

	45		Glarebuster, 13 Watt Compact Fluorescent	Residential lighting at garage door.	YES	NO	YES
Residential: 14B, Bridgehouse	**46**		Glarebuster, 13 Watt Compact Fluorescent	Residential lighting at garage door.	YES	NO	YES
	47		Glarebuster, 13 Watt Compact Fluorescent	Residential lighting at garage door.	YES	NO	YES
	48		Glarebuster, 13 Watt Compact Fluorescent	Residential lighting at garage door.	YES	NO	YES
	49		15 Watt Compact Fluorescent	Residential lighting for handicap walkway.	NO	NO	NO This light will be removed.
Photovoltaic Array Field	**50**		High Intensity Floodlight	Rare night operations of PV array < 1 night per year. For Emergency Use Only	NO	YES	YES
	51		High Intensity Floodlight	Rare night operations of PV array < 1 night per year. For Emergency Use Only	NO	YES	YES
	52		High Intensity Floodlight	Rare night operations of PV array < 1 night per year. For Emergency Use Only	NO	YES	YES

9. Park Interpretive Programs on Night Skies

a) Evening Astronomy Program

Throughout the summer we give evening programs in our campground on astronomy. This is a 45 min. program using PowerPoint and projected on 12 foot screen. This program introduces the public to astronomy, light pollution and night sky protection. It has been giving at Grand Canyon National Park both North and South Rims of the park. The program was given for the last two years at the National Association for Interpretation annual conference.

b) Night Sky Watch Program

This program will be starting this summer. We will be using Volunteer Astronomers to give sky watch programs in our campground. The park also has two telescopes used for evening programs. The volunteers will be setting up telescopes and allowing people to view the planets and stars after the program. This program will start in May and run through the summer.

10. Park Interpretive Programs on Night Skies

a) **Publication #1 : Dark Midnight Skies (Draft)**

This publication covers Night Protection at Natural Bridges how the park has upgraded its lighting at the visitor center and around the park. It also gives people ways to protect night skies at their home. This publication is the foundation of a new interpretation exhibit for our Visitor Center. This exhibit would introduce night sky protection, display the Dark-Sky logo and give people proactive information about making a difference in their own communities.

(Page 1)

Dark Midnight Skies

National Park Service
U.S. Department of the Interior

Natural Bridges
National Monument

Natural Bridges Night Sky Protection

The visual appearance of the sky from the monument is stunning; Natural Bridges has the darkest sky measured by the NPS Night Sky Team. There are no primary sources of light pollution to affect our sky. The only light sources are secondary light sources, which are the Cortez, Colorado, and Shiprock, New Mexico, area to the Southeast and the town of Kayenta, Arizona, to the Southwest.

When you look up into the sky at night you are seeing the same stars that the first people Native Americans would have seen 1000 years ago.

What are Natural Lightscapes?

A "Natural Lightscape" is a place or environment characterized by the natural rhythm of the sun and moon cycles, clean air, and of dark nights unperturbed by artificial light. Natural lightscapes, including dark night skies, are not only a resource unto themselves, but are an integral component of countless park experiences. Here we have so little light pollution that you have the oppotunity is the blinding bright Milkey Way. Dark skys are a resouce that many of us have lost at our homes. Many National Park Service areas are now managing ther lightscape to help protect the night sky. Natural Bridges have replaced all its outdoor lights with shileded lights that shine on the ground, not into the sky.

TERRY ACOMB
NATURAL BRIDGES

Comet Hal-Bopp through
Owatachomo Bridges taken March 26th 1997.

RALPH JONES
NATURAL BRIDGES NATIONAL MONUMENT

Crescent Moon, Saturan, and Vinus setting over Moss Back Bute.

Experiencing Dark Night Skies

Natural darkness is becoming rare. Across the nation outdoor lights have spilled carelessly into the night causing light pollution. This wasted light cast a yellow glow across the night sky for hundreds of miles, drowning out the beautiful view of the stars. National parks harbor some of the last remaining portals of darkness in the country. The NPS has identified dark night skies as an important value and is pleased to share this resource with you.

6 Ways to Enjoy Natural Darkness

1. Conquer your fears
Most people are a bit uncomfortable in the dark. Try walking outside in a very dark area while keeping your flashlight in your pocket.

2. Make a night vision friendly flashlight
By covering your flashlight with red cellophane or a red filter, you can prevent it from disrupting you night vision.

3. Stargaze
Spend time looking thought telescopes and learning about the cosmos with you local science center, astronomy club, or park ranger.

4. Go for a moonlit hike
The full moon provides ample light to see in most places. Let you eyes fully adjust. Be Safe. A full moon hike will be a memorable experience.

5. Awaken you nocturnal senses
Find a comfortable spot and look around. Allow your eyes 20 minutes to adjust, and you may be surprised how well you can see by starlight.

6. Be inspired
The night sky has been an inspiration for myth, literature, art, scientific discovery, and religion. Find your own way to connect with humankind's celestial companion. Revel in its beauty and wonder, and most of all - be inspired!

Saving the Skies and Money

Lighting Types

All living things benefit from natural darkness. The night sky is everyone's hertiage, but light pollution is rapidly eroding the unspoiled view of the stars. This, however, is an easy problem to fix. Replacing poor quality outdoor lights with modern, efficient fixtures is not only good for the environment, but also saves energy and money while improving safety and security. Shielding lights and directing them downward reduces unwanted glare and returns the beautiful night. The starry skies that our ancestors enjoyed can be restored for everybody once again.

Electricity at Natural Bridges National Monument is produced from a photovoltaic system installed in June 1980. The PV array produces up to 50 kilowatts of power. That is more than enough electricity to supply the needs of the small community of National Park Service personnel, their families and the public.

The PV array is located on an acre of land across the road from the visitor center. A short path from the west side of the visitor center parking area leads to a viewing platform. Here, with a push of a button, an audio message explains the photovoltaic process.

The monuments uses fulley shielded lights Compact Fluorescent Bulbs. Thes bulbs create less glare in the skys. A 13 watt compact fluorescent produces the same light as a 75 watt Incandescent bulb. This lights not only help protect the Night Skies but also use much less power then "normal" light bulbs that most people still ues.


13 Watt
Compact Fluorescent


75 Watt
Incandescent Bulb


Unshilded light fixture


Fully Shilded Light Fixture

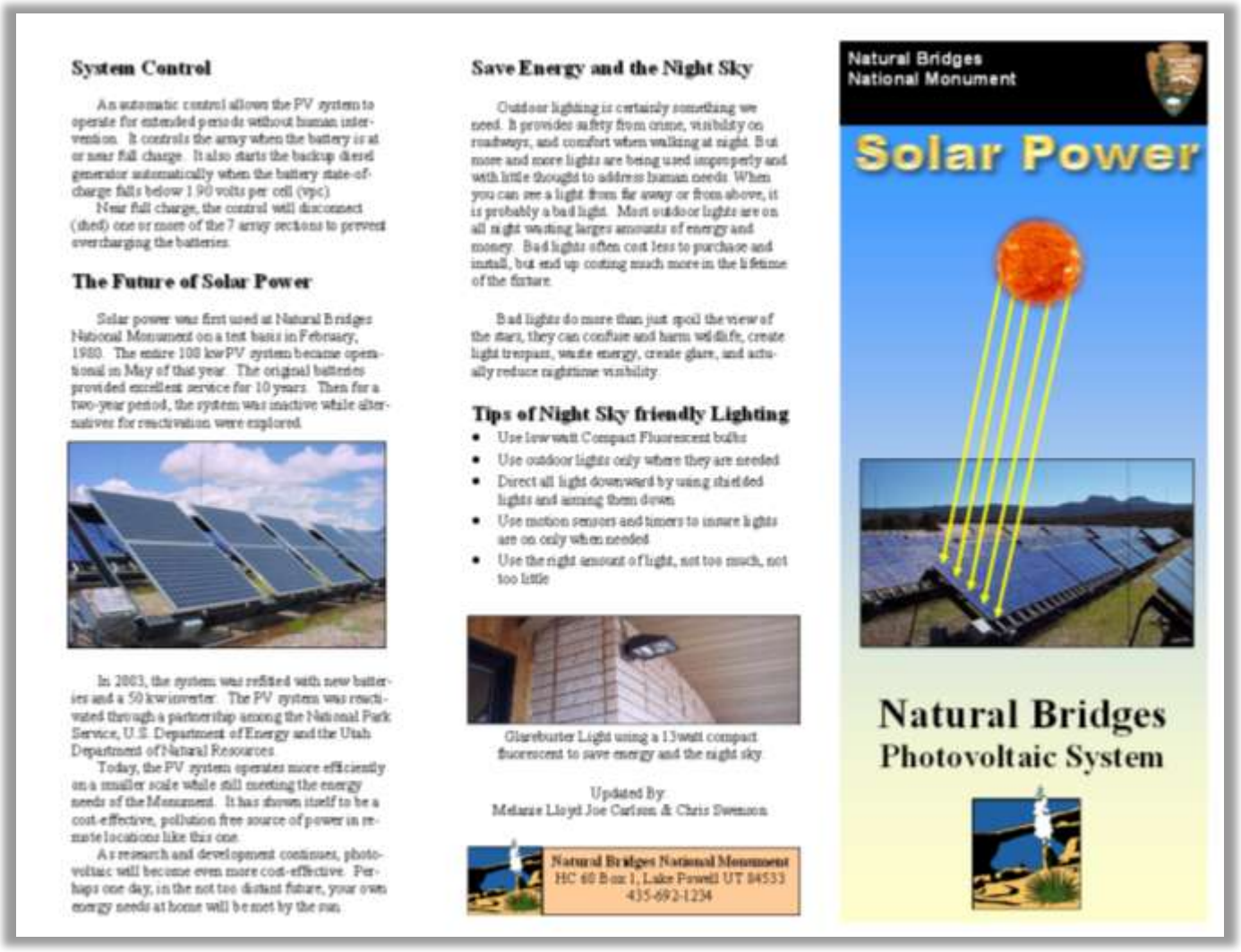
For More Information

Natural Bridges National Monument
National Park Service
HC 60 Box 1
Lake Powell UT 84533
435-692-1234
http://www2.nature.nps.gov/xxxxxx

b) **Publication #2 : Solar Power at Natural Bridges**

The second is on solar power and energy conservation. This is used to answer many questions on how the park can run on 100% solar power. The brochure also has a section on Saving Energy and Night Sky protection.

(Page 1)



System Control

An automatic control allows the PV system to operate for extended periods without human intervention. It controls the array when the battery is at or near full charge. It also starts the backup diesel generator automatically when the battery state-of-charge falls below 1.90 volts per cell (vpc).

Near full charge, the control will disconnect (shed) one or more of the 7 array sections to prevent overcharging the batteries.

The Future of Solar Power

Solar power was first used at Natural Bridges National Monument on a test basis in February, 1980. The entire 108 kwPV system became operational in May of that year. The original batteries provided excellent service for 10 years. Then for a two-year period, the system was inactive while alternatives for reactivation were explored.

In 2003, the system was refitted with new batteries and a 50 kw inverter. The PV system was reactivated through a partnership among the National Park Service, U.S. Department of Energy and the Utah Department of Natural Resources.

Today, the PV system operates more efficiently on a smaller scale while still meeting the energy needs of the Monument. It has shown itself to be a cost-effective, pollution free source of power in remote locations like this one.

As research and development continues, photovoltaic will become even more cost-effective. Perhaps one day, in the not too distant future, your own energy needs at home will be met by the sun.

Save Energy and the Night Sky

Outdoor lighting is certainly something we need. It provides safety from crime, visibility on roadways, and comfort when walking at night. But more and more lights are being used improperly and with little thought to address human needs. When you can see a light from far away or from above, it is probably a bad light. Most outdoor lights are on all night wasting larges amounts of energy and money. Bad lights often cost less to purchase and install, but end up costing much more in the lifetime of the fixture.

Bad lights do more than just spoil the view of the stars, they can confuse and harm wildlife, create light trespass, waste energy, create glare, and actually reduce nighttime visibility.

Tips of Night Sky friendly Lighting

- Use low watt Compact Fluorescent bulbs
- Use outdoor lights only where they are needed
- Direct all light downward by using shielded lights and aiming them down
- Use motion sensors and timers to insure lights are on only when needed
- Use the right amount of light, not too much, not too little

Glareburter Light using a 13watt compact fluorescent to save energy and the night sky

Updated By:
Melanie Lloyd Joe Carlson & Chris Swenson

Natural Bridges National Monument
HC 60 Box 1, Lake Powell UT 84533
435-692-1234

Natural Bridges
National Monument

Solar Power

Natural Bridges
Photovoltaic System

Photovoltaics:
Electricity From Light

July 2005

Electricity at Natural Bridges National Monument is produced from the sun. Solar cells convert sunlight to electricity through a process called photovoltaic, a word meaning electricity from light. When sunlight strikes a photovoltaic (PV) cell, photons interact with electrons in the cell to create direct current (DC) electricity. The DC current is then fed to an inverter where it is converted to alternating current (AC) electricity, the most commonly used form of electrical power. Excess power is stored in batteries for later use.

1981

2003

While only 10 percent of the sun's energy striking the PV cell is converted to electricity, the many cells that comprise the PV array produce up to 50 kilowatts of power. That is more than enough electricity to supply the needs of the small community of National Park Service personnel, their families and you, the public.

Natural Bridges National Monument was chosen as a demonstration site for the use of solar energy in the early 1980's. Situated at an elevation of 6500 feet in Utah's southeastern desert, Natural Bridges' moderate, sun climate makes it an ideal location for a solar energy system. Other factors in this decision include Natural Bridges' remote location away from commercial power sources and the solar system's accessibility to the visiting public.

Following the dedication of the system in June 1980, visitors could see how non-polluting, quiet, cost-effective electric power is produced from the sun.

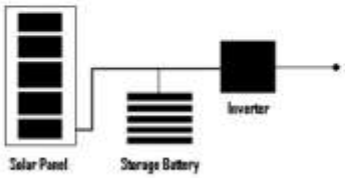
Why Solar Power?

Prior to the installation of the PV system, the Monument relied on Diesel generators for all its electricity needs. The generators operated continuously. The noise and the pollution produced by burning non-renewable fossil fuel were incompatible with Natural Bridges' pristine desert setting. Unlike diesel generators, a PV system is a clean, quiet, safe, nonpolluting source of electrical power, and the sun's energy is nearly unlimited.

Before switching to PV power, the Monument consumed up to 200,000 kilowatt hours of electricity annually. With installation of the PV system and the implementation of energy-efficient measures, the Monument now consumes about 70,000 kWh annually with over 90 percent of that coming from the sun. Most heating and cooking needs continue to be met by liquefied petroleum gas.

How PV Cells Work

The PV cells used here are made primarily of silicon—one of the most abundant elements on earth. When sunlight strikes the surface of the cell, photons from the light are absorbed. These react with electrons on the silicon surface to create a weak electrical current. Many thousands of these cells are wired together to create a PV array.



On its front surface, the cell is coated with a thin grid of collector wires. These tiny wires, together with a conductive back surface, provide the contact through which the power from the cell is delivered. To maximize the amount of sunlight absorbed by the cell, its front surface is also covered with an anti-reflective coating.

Major Components

The major components of the PV power system are shown in the accompanying diagram. Direct current electricity from the array is either stored in lead-acid batteries or passed to a 50 kilowatt inverter, which converts DC electricity into AC electricity.

As a backup power source, the Monument has two 60 kw diesel-powered generators. When needed, power from these generators may be supplied directly to the site and sent to charge the batteries.

Power Storage System

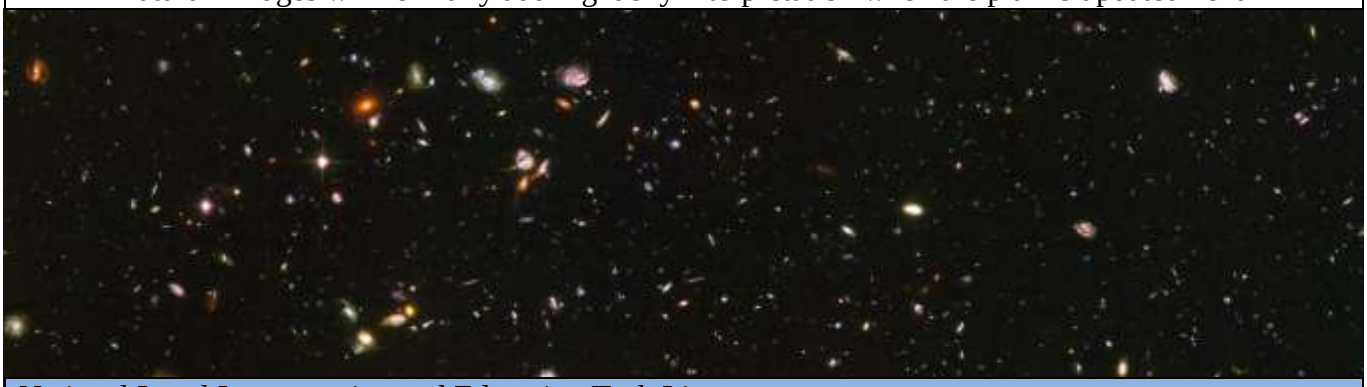
Since solar energy is not always available—at night or on cloudy days—a remote PV system such as the one at Natural Bridges must have a way to store electricity. To accomplish this, 240 deep-cycle lead-acid batteries weighing 200 pounds each are used. These batteries have combined rated capacity of over 600 kilowatt hours, although the maximum drawdown is limited to 480 kwh in order to increase battery life. 450 kwh is enough to operate the Monument for three days without sun.

1994

2003

11. Future Work for Night Sky Interpretation & Protection Action Plan

Park Level Task List
1. Finish park lighting change including removing some lights and replacing others
A few of the lights in the park are on order and will be installed when they arrive. Other lights are scheduled to be removed. This will complete 100% compliance for retrofitting existing lights.
2. Add Dark-Sky page to NABR web site.
This will be completed in March 2007 after the IDA meeting.
3. Create Natural Bridges centennial activities list that will include dark sky education.
This is a planning process that will start in the summer of 2007
4. Work with local BLM Grand Gulch Ranger Station to replace there outdoor lights.
The BLM ranger station is located 15 miles for Natural Bridges. The ranger station is 100% solar powered but does not have night friendly lights. The Bureau of Land Management(BLM) office has agreed to change their lights
5. Add night sky interpretation to parks Comprehensive Interpretive Plan
Each national park area must complete a Comprehensive Interpretive Plan every 5 years. Natural Bridges will formally add night sky interpretation when the plan is updated next



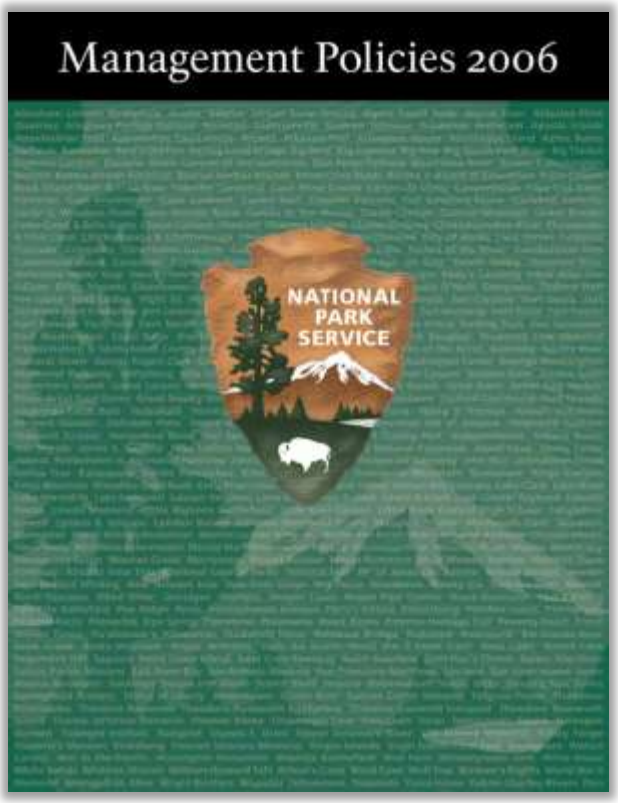
National Level Interpretation and Education Task List
1. Finish NPS Dark-Skies Brochure
The brochure in section 10 of this document will be finished with Dark-Sky Park Interpretation, education and protection information. It will be published as an Adobe PDF document so it can be downloaded from our website and sent out as part of Dark-Skies Interpretation eKit.
2. Start planning of NPS Views Dark-Skies Website. (wilderness, cultural, biological dark-skies)
The "Views" is National Parks Service education website that brings national parks into classrooms. Using national parks as examples to teach natural, cultural and historical themes.
3. Create "How to became an International Dark-Sky Park" guide.
This will be a step by step guide on how a park can become a Dark-Sky Park. It will include many aspects including where what kind of light to buy and where to get time. Contact information for people that can help and other needed information.
4. Start planning National Park Night Sky curriculum
This is curriculum based education materials that will be include for both schools and parks.
5. Dark-Skies Interpretation eKit (brochure, poster, images, PowerPoint, ect)
This is a kit of information that will be available for download for interpreters in national parks that will include brochures, posters, images, PowerPoint programs and more.
6. Individual parks conduct outreach programs to other agencies and venues.
Each individual park should conduct outreach programs within their local and gateway communities and work with other state and federal agencies to raise awareness and unify in the preservation of their night sky resource.

12. Agency Policy on Outdoor Lighting and Dark Sky Protection

National Park Service Management Policies 2006. (These policies govern all areas in the National Park Service)

(Sections that relate to park Lightscape Management)

4.10 Lightscapes Management



The Service will preserve, to the greatest extent possible, the natural lightscapes of parks, which are natural resources and values that exist in the absence of human-caused light. The absence of light in areas such as caves and at the bottom of deep bodies of water influences biological processes and the evolution of species, such as the blind cave fish. The phosphorescence of waves on dark nights helps hatchling sea turtles orient to the ocean. The stars, planets, and earth's moon that are visible during clear nights influence humans and many other species of animals, such as birds that navigate by the stars or prey animals that reduce their activities during moonlit nights.

Improper outdoor lighting can impede the view and visitor enjoyment of a natural dark night sky. Recognizing the roles that light and dark periods and darkness play in natural resource processes and the evolution of species, the Service will protect natural darkness and other components of the natural lightscape in parks. To prevent the loss of dark conditions and of natural night skies, the Service will minimize light that emanates from park facilities, and also seek the cooperation of park visitors, neighbors, and local government agencies to prevent or minimize the intrusion of artificial light into the night scene of the ecosystems of parks. The Service will not use artificial lighting in areas such as sea turtle nesting locations where the presence of the artificial lighting will disrupt a park's dark-dependent natural resource components.

The Service will

- restrict the use of artificial lighting in parks to those areas where security, basic human safety, and specific cultural resource requirements must be met;
- use minimal-impact lighting techniques;
- shield the use of artificial lighting where necessary to prevent the disruption of the night sky, natural cave processes, physiological processes of living organisms, and similar natural processes.

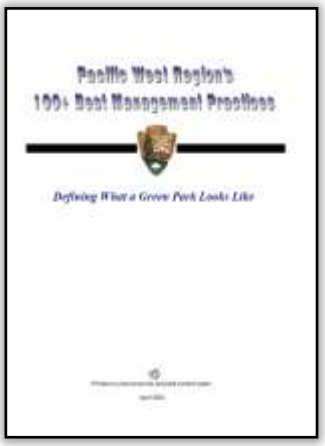
The decision about whether or not to install artificial lighting in particular circumstances is left to the discretion of the superintendent and is made through the planning process.

9.3.1.4 Amphitheaters
Amphitheaters may be provided in campgrounds and in other locations where formal interpretive programs are desirable. Campfire circles may be provided in campgrounds to accommodate evening programs and informal social gatherings. Artificial lighting must be carefully directed and kept to a minimum, with due regard for natural night sky conditions.

9.3.2.1 Campgrounds
When necessary for basic safety requirements, pathways and the exteriors of buildings and structures may be lighted. Such lighting will be energy efficient and shielded as much as possible so that visitors have the opportunity to experience the natural darkness and night skies.

13. Park Management Documents Supporting Dark Skies

Natural Bridges Environmental Management Systems Plan



The NPS is still developing general lighting guidelines for parks. Until the time of completion and approval, an Interim Lighting Guideline is available to inform exterior lighting decisions

Currently, outdoor lighting is reviewed through the National Environmental Policy Act (NEPA) process for projects within the park and those federally related projects adjacent to the park. This should improve the likelihood that poor quality outdoor lighting will be intercepted and improved before any construction or activity unduly disrupts the nighttime environment. At the next periodic review of the Parks General Management Plan, protection of the natural lightscape will be fully articulated and specified for Natural Bridges National Monument.

Natural Bridges has Environmental Management Systems Plan. This plan covers all outdoor lighting and energy conservation. This plan states that when possible Natural Bridges National Monument will use the "Pacific West Region's 100+ Best Management Practices" of April 2002. Below is a Lighting and Energy Conservation section of the Best Management Practices.

Pacific West Region's 100+ Best Management Practices				
LIGHTING AND ENERGY CONSERVATION				
ACTIVITY	**BEST MANAGEMENT PRACTICE**			
	SIMPLE	**ADVANCED**	**MORE ADVANCED**	**REFERENCE**
Light Pollution Sources: NPS, Concession, Visitor, External	Develop plans to minimize or eliminate light pollution in the Statement of Park Management, the GMP, and RMP. Eliminate unnecessary lights. Carefully match outdoor lighting levels with application. Install motion sensors and other controls. Educate staff and visitors/partners to change practices causing light pollution. Sensitize them to the benefits of dark night skies.	Enforce light limits. Use lowpressure sodium, low-voltage, or photovoltaic lights. Shield light sources with directional devices.	Work with those who generate light pollution outside park boundaries to modify/re-engineer intrusive light sources. Help develop local ordinances to control intrusive light pollution impacting parks and visitors.	*Federal Lighting Guide:* www.eren.doe.gov/femp /resources.html Illuminating Engineering Society of North
Building Sitting	Orient buildings to use passive solar energy and natural ventilation. Use north wall design that minimizes heat loss.	Use LEED standards.		FEMP training on passive solar design: 800-363-3732 Low-energy building design
Building Design/Solar Energy	Use light-colored roofs and pavement to minimize heat island effect. Maximize insulation and minimize infiltration of building envelope. Use appropriate window glazing. Choose glazing with low solar heat gain in southern climates. Use wall shading. Seal and insulate ductwork. Incorporate natural cooling in design.	Use air movement techniques and desiccant ehumidification (latent heat removal is preferred). Use active solar system (e.g., water heating and photovoltaic power). When reroofing, switch to a protected-membrane system.	Heat and cool by non-fossil fuel sources (100% renewable power). Use photovoltaic or hydrogensource fuel cells. Consider removing power lines and substations.	www.ornl.gov/roofs+walls www.energystar.gov http://ateam.lbl.gov/publications.html
Day Lighting	Use natural daylight strategies to reduce lighting energy use and cooling requirements. Use dimming electronic ballasts and control banks of luminaries along window walls that are separate from interior lights.	Bring daylight in high, bounce off surfaces, filter with vegetation and architectural components, and integrate with electric lighting and HVAC systems.	Assess light pipes, light shelves, fiber optics, tracking daylight apertures, and other advanced techniques.	www.nrel.gov/buildings_thermal www.daylighting.org www.pge.com/pec/daylight
Fixtures: Lighting	Install high-efficiency EXIT signs (LED). Use high intensity discharge (HID) lamps and/or fluorescent lights (T-8's or T5's with electronic ballasts) in all fixtures used for more than 3 hours a day. Do not use CFL in outdoor cold areas. Install occupancy sensors. Promptly replace fluorescent lamps that strobe or have blackened ends. Buy low-mercury products.	Lower the ratio to one watt/square foot or less in general office space. A combination of infrared and ultrasonic sensors may work best.	Upgrade lighting system when HVAC is upgraded.	www.eren.doe.gov/EE/buildings.html www.iesna.org www.lrc.rpi.edu
Fixtures: Heating and Cooling	Use ceiling fans. Set thermostats not to exceed 68° F, cooling not to exceed 86° F. Install programmable electronic thermostats and timers (e.g., bath fans).	Consider paddle fans in high ceilings		EO 12902 *Energy Efficiency and WaterConservation at Federal Facilitie*
Appliances	Reduce hot water T to 120° F (reducing below 120° F may allow bacteria to grow inside hot water tanks). Buy clothes washer with energy rating of 800 kWh/yr. max., and horizontal axis washing machines. Choose electronic ignition for gas dryer and range. Refrigerator with energy rating of 800 kWh/yr. max.	Minimize risk of combustion gas spillage by using sealed-combustion dishwashers with energy-saving cycle and energy rating of 620 kWh/yr. Replace conventional garbage disposals with pullers.		www.energystar.gov www.eren.doe.gov/EE/buildings.html FEMP Help Desk: 800-363-3732
Office Equipment	Must have Energy Star label. Laptops use less energy. Activate energy management features. Screen savers DO NOT save energy (need to auto-switch to sleep/hibernate mode or manually turn off). Turn-off equipment when not in use.	Ink-jet and bubble-jet printers use less energy than laser. Use direct computer faxing or e-mail (copiers use more energy than any other office equipment).		EPA *Greening Your Purchase of Electronics*, Dec. 2001, and EPA *Greening Your Purchase of Copiers*, Dec. 2001. www.epa.gov/oppt/epp
Education on Simple Practices	Educate employees on turning off lights; closing windows and doors; weather stripping; turning off computers, etc.; washing and drying full loads of laundry; and using soaps that perform at lower T.	Assess employee transportation patterns; invite carpooling.		

National Park Service

Interim Outdoor Lighting Guidelines (DRAFT)

Developed by the
NPS Night Sky Team
Ver 1.0
1/30/2007

Overview

Purpose and Need

The US National Park Service has lacked servicewide outdoor lighting guidelines. The need for better quality lighting and guidance to parks is clear by the variable quality of lighting installations found throughout several parks and the increased concern that park facilities are causing degradation of the nighttime environment. This lighting guideline is a simplified document intended to help parks immediately address lighting concerns, guide development and compliance, and provide a best management practice template to parks and park partners. The Night Sky Team will be developing a final document with finer, more detailed guidance, in cooperation with more NPS staff, Musco Lighting Company (through a cooperative agreement via the National Park Foundation), the International Dark Sky Association, and other researchers and partners.

2006 Management Policies

The 2006 NPS Management Policies (slightly modified from the 2001 version) direct the NPS to conserve natural lightscapes. Protection of natural darkness is not only a visitor resource and scenic value; it has important connection to cultural landscapes, ecological integrity, operational efficiency, and sustainability.

4.10 Lightscape Management

The Service will preserve, to the greatest extent possible, the natural lightscapes of parks, which are natural resources and values that exist in the absence of human-caused light. The absence of light in areas such as caves and at the bottom of deep bodies of water influences biological processes and the evolution of species, such as the blind cave fish. The phosphorescence of waves on dark nights helps hatchling sea turtles orient to the ocean. The stars, planets, and earth's moon that are visible during clear nights influence humans and many other species of animals, such as birds that navigate by the stars or prey animals that reduce their activities during moonlit nights.

Improper outdoor lighting can impede the view and visitor enjoyment of a natural dark night sky. Recognizing the roles that light and dark periods and darkness play in natural resource processes and the evolution of species, the Service will protect natural darkness and other components of the natural lightscape in parks. To prevent the loss of dark conditions and of natural night skies, the Service will minimize light that emanates from park facilities, and also seek the cooperation of park visitors, neighbors, and local government agencies to prevent or minimize the intrusion of artificial light into the night scene of the ecosystems of parks. The Service will not use artificial lighting in areas such as sea turtle nesting locations where the presence of the artificial lighting will disrupt a park's dark-dependent natural resource components.

The Service will:

- *restrict the use of artificial lighting in parks to those areas where security, basic human*
- *safety, and specific cultural resource requirements must be met;*
- *use minimal-impact lighting techniques;*
- *shield the use of artificial lighting where necessary to prevent the disruption of the night sky, natural cave processes, physiological processes of living organisms, and similar natural processes.*

The decision about whether or not to install artificial lighting in particular circumstances is left to the discretion of the superintendent and is made through the planning process.

Existing Standards and Codes

There are a variety of existing lighting standards, many of them in conflict and each focusing on variable aspects of lighting needs. Many of them are far more complex than is suitable for a small or medium sized park, seldom recognize the unique lighting needs of a national park, nor do they adequately address the recent rise in concern about light pollution. There are also other codes and standards currently being developed; these include the International Dark-sky Association (IDA) Model Lighting Ordinance, the New Buildings Institute Lighting Guidelines, and others. It should be noted that two national parks have made significant efforts on outdoor lighting— Yellowstone and Yosemite. Yellowstone has completed lighting guidelines while Yosemite has developed draft lighting guidelines that are currently undergoing additional revisions.

The interim lighting guidelines presented here are an amalgamation of several current and developing guidelines. They are intended to be used by most parks, although very large parks may find them not detailed enough or not addressing some unique situations. In cases where situations fall outside the realm of this document, further review and analysis, preferably through the NEPA process, is highly recommended. Thus, this document is designed to address 90% of the situations that arise in outdoor lighting.

It should be noted that the lighting recommendations contained herein produce illumination levels sometimes significantly lower than IESNA recommended practices. The trend in newer guidelines, such as ASHRAE 90.1 and the IDA MLO, is clearly toward lower illumination levels, especially in darker ambient environments. In most cases, parks have ambient light

levels much lower than what was examined when many of these guidelines were developed. Lower ambient light levels often require less light, thus the disparity between IESNA standard and recommendations in this document.

Examples of existing codes and standards include:
• NFPA Codes and Standards, but not NFPA 5000
• NESC National Electrical Safety Code
• IEEE- Standards
• Illuminating Engineers Society of North America 9th edition (IESNA)
• UL – Underwriter's Laboratory (Product Safety)
• Americans with Disability Act (ADA)
• ASRAE/IESNA 90.1 / 1999 (Energy Efficiency)
• LEEDS (sustainable building standards)
• EPA Energy Star
• New Buildings Institute Lighting Guidelines
• California Title 24 Building Code (Outdoor Lighting)
• International Dark-Sky Association (IDA) Pattern Lighting Code
• IDA Model Lighting Ordinance

Guideline Objectives
The objectives of this lighting guideline are to provide parks a planning strategy and best management practices for outdoor lighting. An important consideration in this document was balancing the need for safety with the sensitivity of the park nocturnal environment. The guideline focuses on "off the shelf" solutions, though development of new technologies like LEDs will soon allow parks to more precisely manage outdoor lights; however, for now only mainstream technologies have been included in this document. Simplicity of understanding and implementation of these guidelines was given greater weight than the details of lighting design, visibility research, and energy efficiency.

- Curtail and reverse the degradation of the nighttime visual environment and the night sky, including casual observation, astronomy, and air quality related values.
- Minimize glare, light trespass, obtrusive light, and artificial sky glow by limiting outdoor lighting that is misdirected, excessive, or unnecessary.
- Insure "good neighbor lighting" by minimizing light trespass.
- Help minimize suspected health risks to humans from adverse exposure to light at night.
- Help protect natural ecosystems from the damaging effects of night lighting.
- Permit reasonable and rational use of outdoor lighting for nighttime safety, utility, security, and productivity.
- Help to conserve energy and resources.
- Minimize maintenance and operating costs
- Provide some flexibility for architectural and artistic lighting within the above constraints

Scope
This guideline is intended to address outdoor lighting within park boundaries, including developed areas and concessions. It also may be applicable to other parklands or federal lands. It omits transportation right of ways where state and federal transportation codes may super cede park authority.

Complex facilities and lighting situations may require more guidance than is found here. In those cases, consultation with additional guidelines, lighting engineers, and the NPS Night Sky Team is encouraged.

Outdoor Lighting in a Park Setting
Virtually all national parks will have some need for outdoor lighting. As directed by the NPS Management policies, it is important to specify the need in every case of outdoor lighting and then choose a lighting design that meets those needs. Too often, lighting does not exist where there should be some, the quality of the lighting is poor, or the brightness level is many times higher then what is required.

When less is better
Lighting engineer James Benya has done a substantial amount of research in Yosemite NP on appropriate lighting levels. His findings, not widely available, indicate that levels much lower than IESNA recommended practices are adequate and quite appropriate for a national park environment, even ones as populated as Yosemite Valley. These findings, combined with field experience retrofitting outdoor lighting and emerging ethics in the lighting engineering community have lead to lighting design that finds a balance between the positive and negative attributes of light using higher performance designs at much lower illumination levels.

Human needs
Lighting serves both objective and subjective human needs. Objectively, light is used to provide adequate visual perception in low light. Although a healthy human eye is capable of adequate visual perception in very low light levels, full dark adaptation can take several minutes. Additionally, the eye cannot easily transition from a bright environment (such as indoors) to a dark environment (such as outdoors at night). Thus outdoor lighting is needed to provide a minimal illumination level and ease high contrast transitions. The more detailed the visual task, the more light is typically needed. It is important to note here that human eyes function by reference to contrast, not absolute illumination. At night, one can perceive that 10 footcandles (a common measure of illumination) is twice as bright at 5 footcandles, but it has not built in ability to quantify light amount. If those same lights were gradually dimmed to 5 fc and 2.5 fc respectively, the eye may not be able to distinguish any change. Thus, the setting that a light fixture is in— the ambient light level, the lighting uniformity, the glare, and the transition a human experiences in that space are more important than an absolute illumination level. The thoughtless adherence to engineering standards without consideration of the setting is ill advised. Ultimately, visual performance in an artificial lighting environment is more closely tied to lighting *quality* than lighting *quantity* (Lighting for Exterior Environments, RP-33-99).

Safety can be defined as *freedom from danger*, an objective requirement of lighting. Security can be defined as *freedom from worry*, a subjective aspect of lighting. Generally, lighting provides both, but gauging what type, amount, and quality of light is necessary for an adequate level of security is difficult (Lighting for Exterior Environments, RP-33-99). "Too often, people associate more light or brighter light with *safer* surroundings. It can be easily demonstrated that too much light or poorly directed light, causes a loss of visibility. For example, if a light is too bright, it prevents a person from discerning important detail because of the *high brightness contrast* or glare which causes a silhouette effect." Quality park outdoor lighting may not appear to some visitors to meet their security needs at first glance, especially if they have come to associate a glary environment with security, but they should soon discover that such quality lighting has several advantages.

Transitions
Unlike an urban environment where one transitions from one lit area to another lit area, a park typically has a few isolated lit areas surrounded by naturally dark spaces. The ambient light level is much lower, expectations of amenities are different, there is a emphasis on self reliance (for example, they may be carrying a flashlight), and transitions from one area to another are more important. The low ambient light level allows *less* light to be used to provide visibility and security, provided glare is properly controlled. Additionally, some areas should not be lit, either by the desire of the park management, the visitor, or both.

Accessibility Standards
It is a requirement to provide accessible routes which meet standards set by the Americans with Disabilities Act (ADA). However, the ADA does not give guidelines on appropriate lighting levels for accessible routes. Lighting on accessible routes should follow the general guidelines stated here. In order to accommodate people with impaired vision, lighting should maintain a continuous illumination, minimize glare, and not create a spotty effect.

Problems with Light
Light is not innocuous. It is an alteration of our environment like so many other human construction, but it has received little attention as a significant environment change until recently. As seen from the many images of the Earth from space, outdoor lights have sprung up throughout most of the globe. The simple fact that light is visible from space, directly overhead, shows how easily this human tool leaks out into the natural environment.

Light Pollution
The upward spill of light is often called light pollution. "Dust, water vapor and other particles will scatter and reflect light that is emitted into the atmosphere creating sky glow. Light that escapes directly upward into the night sky is a major contributor to the loss of the dark night sky. Even light from a few fixtures can create an unnatural glow over a wide area" (Yellowstone Lighting Guidelines 2005). Light from cities has been documented by the NPS as being visible from over 200 miles away. Even a long streetlight in the countryside can be seen for tens of miles. Most of the upward flux if from light escaping the fixture horizontally or upward. A small fraction of light pollution, perhaps 15%, is caused by reflection off the ground and other surfaces. Direct uplight is controlled by using *full cut-off* (sometimes called shielded) fixtures. This is thought to reduce the direct uplight component to less than 25% of its former value. The reflected light component is controlled by using the minimal illumination level necessary.

Minimizing this sky glow is essential in maintaining a natural nocturnal lightscape, and sets an important example for park visitors and neighboring communities.

Light Trespass and Glare
Light that shines sideways (horizontally) from a fixture is not only a significant source of light pollution, but it is more apt to trespass into areas where light is not wanted. This low angle light is also the principle source of glare. This glare light strikes the eye directly, and carries no visual information, unlike the reflected light from illuminated surfaces which caries information of depth perceptions, texture, detail, color, shape, etc. Glare can cause minor discomfort, or it can completely disable the eye's ability to see properly. Even when present in low levels, it will cause the pupil to constrict down, diminishing the remaining light in the visual field. Glare should be minimized in all circumstances to both improve the lighting quality and to minimize light trespass. Solutions for this include using full cut-off or partial cut-off fixtures, aiming lights away from typical observation angles, aiming lights downward, increasing lighting uniformity, and reducing brightness levels of lights.

It is important to note that interior lights may shine outside the structure (especially common in clear-story windows in restrooms) causing the same effect as a poor quality outdoor light.

Ecological and Health Impacts
"Every year there is more research suggesting that artificial light is affecting the natural environment and the biological rhythms of both plants and animals that are critical to native habitat and natural evolution. Effects of artificial light on wildlife can cause avoidance or attraction behavior with diverse and significant consequences that not only affect the species themselves but those on which they prey and those that prey on them. Research to date has concentrated on the affects of artificial light on birds and insects, but there is evidence that light affects larger animals. Mammals that travel long distances to find food or mates, such as mountain lions, may avoid links between natural areas if the areas emit artificial light" (Yellowstone Lighting Guideline 2005).

Because the scientific literature is relatively sparse on this topic, there is frequently no species specific information available. However, there are some generalities that are useful guides. Nocturnal predators are particularly affected by artificial light, either positively or negatively, which can have resultant impacts on their prey species. Birds, many of which migrate at night, are particularly prone to disorientation by artificial lights. Certain biomes are believed to be more sensitive. These include wetland and ponds, shorelines, alpine areas, and open country such as deserts and prairie. The NPS is currently working with researcher to provide lighting guidance as it relates to wildlife and these will be incorporated in the finalized document.

Finally, humans are animals too, and there is a solid body of research linking artificial light at night (as well as decreased light exposure during the day) to a myriad of health problems.

Sustainability
Outdoor lighting is the last appliance that has received so little energy efficiency scrutiny. Though the different types of lamps are well studied (for example a 4x energy savings is realized by replacing a traditional light bulb with a compact fluorescent), the question of what type of fixture, how much light, and if an area should be lit at all has not seen much discourse. It is estimated that the portion of light that shines upward and creates light pollution represents $2 to $5 Billion annually in the US. Thus, saving our night skies can have tremendous economic and energy benefits.

Designing for efficiency
The basic tenants of efficiency are to use light only when and where it is needed, and if needed, use the most efficient light source that meets the task requirement. Lamp technology has evolved much, and efficiencies can be improved 2x-5x by using modern lamp types. Reducing light levels are a viable solution if illumination can be reduced while still meeting the task, yielding similar efficiency gains. Full cut-off shielding reflects all that light that would go into space downward, further improving efficiency. And finally smart technologies, from the very basic timer or motion sensor, to elaborate computer controlled lighting and LED lamps can further improve efficiencies.

Maintenance Cost
What is energy efficient is almost always cost efficient. But another aspect of cost reduction is maintainability. Lighting design should include workload estimates related to upkeep. Capital cost should be compared with energy efficiency and maintenance intervals to get a true picture of the cost of lighting. All too often, lighting choices are made based only on fixture cost. A $40 "yardblaster" light can be purchased at a hardware outlet, compared to a high end fixture (or luminaire as they are often called) costing $400. However, if the "yardblaster" is 175 watts and the full cut-off luminaire is 18 watts, the capital cost will be offset by energy savings in 4 years. Over a 20-year fixture lifetime, the difference becomes $1200.

A similar comparison can be made with lamp lifetimes. A typical incandescent lamp will last about 1500 hours, compared to 10,000 hours for a compact fluorescent lamp(CFL). The old fashioned light bulb will be changed 6 or 7 times before the CFL burns out, more than making up for its higher initial cost.

Design

Lighting is an important element in architecture and landscapes. It can emphasize spaces, highlight the landscape, and serve purposes beyond the basic need for visibility. Just as the NPS has graphic identity guidelines and a park may have certain sign design standards, the lighting too may be part of such a design vision. Design issues can include pole height and pole spacing, fixture appearance, illumination pattern, light level, or light color to name a few. Lighting is often an important architectural element, however, architectural and artistic lighting may not be appropriate in parks. Washes of light on building, lit statues, dramatically lit boulders or waves are often not appropriate and cannot be justified under the current management policies when the purpose is merely vanity.

Lamp Color

One element that receives much attention is the color of the light. Different lamp technologies, such as High Pressure Sodium (HPS) or Low Pressure Sodium (LPS) produce yellow light. This monochromatic or color biased light cannot render colors properly (these are often described as having a low color rending index). Many feel that this light has an industrial character. Research indicates that less light is needed (and therefore less energy) for the human eye to see efficiently with a white (blue/green) light source than with a more yellow light source. However, HPS and LPS lights are more efficient than white light sources such as Metal Halide (MH), Mercury Vapor (MV), or even Compact Fluorescent Lamps (CFL), producing more lumens per watt. They are also believed to be less impacting to nocturnal wildlife. For example, LPS is often used on turtle nesting beaches with good success. Additionally, the yellow lights scatter much less in the atmosphere and are 2.5x (HPS) to 5x (LPS) less interfering with human night vision than white light. This is an important factor in maintaining dark night skies. The color rending abilities and improved visibility of white lights are at odds with their lower energy efficiency, wildlife impact, and night sky impact, causing frequent professional disagreement. The bias of this guideline is to use yellow lights sources as a default when available unless the need for better color rendition is demonstrated.

Historic Integrity

Historic structure and cultural landscapes have particular lighting needs that may not be addressed in this document. Both the light fixtures themselves and the character of the light they produce are of concern. Often there is too much emphasis on selecting fixtures that look of the appropriate period, while the nighttime scene is neglected but just as important to the historic integrity.

Lighting Guidelines

Approaches

There are several ways to define lighting. They can be divided into two categories— *prescriptive* where the type, size, lamp, etc of the light is defined, or *performance* where the resultant illumination levels are defined. The latter is more accurate, but requires computer modeling and photometric data on each light fixture. Because so many of the fixtures used in parks are low cost ones without photometric or custom designs, and lighting expertise to run computer models is rare, a prescriptive approach is taken here.

There are several aspects of lighting design that can be controlled and defined. The ones chosen to be prescribed in this guideline are limited for simplicity and bolded.

Prescriptive Parameters	**Performance Parameters**
Lumens	Illumination (minimum, avg, max)
Watts	Glare or Glare Ratio
Power density	Uniformity (average:minimum)
Lumen density	Uplight and light distribution
Pole spacing	Spill light/light trespass
Pole height	Transition
Fixture shielding and aiming	

Zones

Two zones should be established in a park. One zone should be a zone where permanent lighting fixtures are not permitted. The second zone should be where permanent outdoor lighting is allowed within the guidelines.

Typical Lighting Zones	**Description**
No Outdoor Lighting	All wildland areas and viewpoints
Lighting Allowed	Developed facilities area

Planning and Compliance

Lighting has been considered a routine maintenance practice and has therefore escaped much of the planning and compliance process. This has lead to the current situation where light pollution in parks is not only the result of lights in distant cities, but is caused by the park itself. The 2006 Management Policies clearly indicate lighting should be part of the planning and compliance process. This interim guideline was intended to ease this process and provide more autonomy to facility and concession managers when working within the guideline.

Cumulative Effect

Though cumulative effect has not been directly addressed in the guideline, it is recommended that parks not only consider the specifications of an individual light, but what the total impact of a new or expanded light project would produce. Though these guidelines mitigate negative impacts to the maximum practical extent, dramatic increases in installed lights will have a noticeable impact. Fortunately, for many parks with an installed base of mixed quality lights, offsetting impacts from new projects is fairly easily done by retrofitting additional poor quality lights.

Lighting Applicability

Where there is an expectation by the visitor or employee of darkness and people are generally prepared for darkness (either through dark adaptation or carrying their own flashlight), lights should not be installed.

Lights should be installed as an illumination transition on commonly used building egress points, where outdoor work may be done at night, where critical information is posted, to draw nighttime visitors to important information or safety point (such as a phone booth or visitor center entrance), where there is a demonstrated need for protection of assets, where there is an identified safety hazard, or where facilities are commonly used at night (such as a laundry room in residence area).

When choosing whether to light an area, it is important to consider the cumulative effect of the action as well as if the illumination will be successful in its desired function. It is also important to consider illumination transitions; an isolated light may effectively light a small area but will render the surrounding dark area less visible.

Security lighting where no patrols exist (such as a remote storage yard) is often counterproductive, inviting crime without the opportunity to intercede.

Requirements

Exterior Lighting

All permanent exterior lighting shall be fully shielded and use the proper illumination level. When fixtures are articulating, such as PAR floodlamps, they should have directional shields, should be aimed within 45 degrees of downward, and should not illuminate areas outside the intended target.

Special Use Lighting

Unshielded and partially shielded fixtures are permitted for low voltage LED pathway lights, under-canopy lights at phone booths, and other guidance lighting provided they are ≤ 7 watts each.

Prescriptions

Maximum Lamp Lumens

7000 lumens is the maximum allowable lamp output (except for emergency lighting). In most cases, 500-1500 lumens will be sufficient.

Pedestrian Walkways	
Maximum Lamp Lumens	1000
Recommended Light Types	Low voltage LED guidance lighting or very low lumen fully shielded lamps. Higher illumination steps or uneven ground.
Recommended Illuminated Area	Pathway and area immediately adjacent to path.
Recommended Duty Cycle	Timer for operation during frequently used times.

Residential Surrounds (Private Buildings)	
Maximum Lamp Lumens	2000
Recommended Light Types	CFL 500-1000 lumens.
Recommended Illuminated Area	Light dispersal limited to residential boundary
Recommended Duty Cycle	Mix of switches (for occasional use), and motion sensors.

Building Egress Points (Public and Staff Buildings)	
Maximum Lamp Lumens	3000
Recommended Light Types	CFL 500-1500 lumens. Forward throw fully shielded fixture.
Recommended Illuminated Area	Egress point and surrounding approach. Transition from lit to dark area should be gradual reduction in illumination with no hard shadows.
Recommended Duty Cycle	All night operation at critical safety, frequently used, and visitor contact points. Motion sensors or user accessible switches for other tasks.

Parking Lots	
Maximum Lamp Lumens	7000
Recommended Light Types	Not generally recommended. If required, light with LPS or HPS lamps of 3500-7000 lumens (depending on pole height).
Recommended Illuminated Area	Portion of parking lot used at night.
Recommended Duty Cycle	Switched with timers to prevent all-night operation.

Safety and Work Areas (Fueling Station, Generator Bay, etc)	
Maximum Lamp Lumens	7000
Recommended Light Types	CFL of 1200-3000 lumens for most applications. Fully shielded lights.
Recommended Illuminated Area	Only immediate work area.
Recommended Duty Cycle	User controlled switches or power-interrupt sensor.

Lamp Selections

The standard lamp shall be a cold-start compact fluorescent lamp (CFL), ideal for its high energy efficiency and range of wattages. These should produce less disruption to the nocturnal species and human experience of the night than a 70-watt High Pressure Sodium (HPS) lamp provided the CFL lamps are 26 watts or less. Incandescent lamps may be used with motion sensor lights. Lighting requiring more than 2000 lumens should use HPS lighting.

Other Situations

Sign Lighting

Internally illuminated signs should be light lettering on a dark background and should not be lit after the related facility has ceased operation for the night. Externally illuminated signs should be lit from the top downward with fully shielded or partially shielded fixtures and should use the minimum amount of light necessary. No specific guidelines are established in this interim guideline, however it is recommended that sign lighting only be employed where it is clearly necessary and that luminance be limited to approximately 1000 lumens or less per side per modest size sign, depending on viewing distance and ambient light level.

Flag Lighting

The preferred practice for staffed federal facilities is to raise and lower the American flag daily at staffed federal facilities. There are only a handful of federal sites where flags are intended to fly all night, such as the Tomb of the Unknown Soldier. There is a growing misconception that flags should be up all night and should be lit. At active federal sites there is little excuse to not honor the flag daily by its raising and lowing. The Patriot Act of 1976 requires nighttime flags to be lit, but does not in any way indicate patriotic preference for leaving the flag up during darkness. Recently some top-down lighting solutions for flags have come to market. This will allow full compliance of flat lighting if there is such a need.

Exempt lighting

1) Where OSHA states that specific lighting levels are necessary for work situations these are considered exempt from the Lighting Guidelines. However, although the lighting levels for the actual work environment must meet OSHA requirements all measures outlined in this document must be taken to exercise best energy practices and shield the light from the surrounding environment.

2) Emergency lighting is exempt from these controls provided it is not used for routine maintenance or scheduled functions. Typically, emergency lighting is used once a year or less and is necessary for human safety in emergency or unforeseen circumstances.

3) Traffic safety warning lights and speed indicators are NOT automatically exempt but should be considered on a case by case basis.

4) Holiday lighting provide they are only operation during the holiday period

*"**If the Stars** should appear one night in a thousand years, how would men believe and adore... But every night come out these envoys of beauty, and light the universe with their admonishing smile."*

Ralph Waldo Emerson

Appendices

Glossary

Fully shielded - a fixture that throws light downward only and in which the lamp itself is shielded so that it can not be seen except from under the fixture.

Full-cut-off – a fixture that is fully shielded and has virtually no part (or a negligible amount) of the fixture lit below the horizontal.

Cut-off - is a fixture that shields upward light causing light to shine both downward and sideways only.

Luminance – is the quantity of light reflected or emitted toward an observer, i.e., the light an observer sees.

Illuminance – is a measure of light in either foot-candles (imperial) or lux (metric). Technically described as flux density per unit area.

Brightness – is a subjective sensation to measured luminance.

Glare –

- ***Disability Glare*** (veiling luminance) – is stray light scattered within the eye reducing the contrast of the image.
- ***Discomfort Glare*** – is high contrast or non-uniform distribution of luminance in the field of view.
- ***Nuisance or annoyance glare*** – is not quantified but is basically annoying light such as "the light shining in the window".

Visual Adaptation to Light –

- ***Photopic Vision*** – is the eye's response at high light levels when cones are used to determine color and to focus on objects.
- ***Scotopic Vision*** – is the eye's response at low light levels such as moon-light when rods are used. Peripheral vision is strong and everything appears in shades of gray.
- ***Mesopic Vision*** – is a combination of photopic and scotopic Vision.

- *All definitions "Lighting for exterior environments" IESNA*

Lamp Characteristics

Lamp types should be carefully chosen. Proper lumen output, efficiency, and spectral characteristics should be key elements in the decision. Other factors to consider should be lamp life, lamp available and cost, aesthetics, and appropriateness.

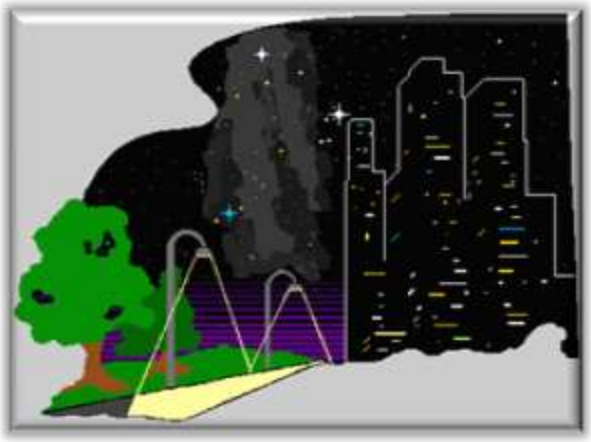
The following are allowed under these guidelines when specifically permitted.

Table 6 – Typical lamp characteristics

Lamp	Watts	Lumens (initial output)	Lumens/watt (efficiency)	Lifetime (hours)	Color Rendering
A-Lamp Incandescent	40	500	12	1000	100
	60	850	15	1000	100
	100	1600	16	1000	100
Compact Fluorescent	7	400	57	10000	85
	13	775	60	10000	85
	23	1400	60	10000	85
	26	1650	65	10000	85
	42	2800	65	10000	85
Metal Halide	39	2800	72	6000	85
	50	3700	75	6000	85
	100	7500	75	6000	85
	150	10500	70	6000	85
High Pressure Sodium	35	2200	50	24000	40
	50	3700	60	24000	40
	70	6200	75	24000	40
	100	8000	80	24000	40
	150	14500	85	24000	40
Low Pressure Sodium	18	3800	150	18000	0
	35	6800	150	18000	0
	90	15300	150	18000	0

Note- High color rendering combined with total brightness typically results in higher impact to nocturnal environment.

Dark-Sky Park Program



International Dark-Sky Association

3225 N first Ave - Tucson Arizona 85719 - 520-293-3198 - www.darksky.org

To preserve and protect the nighttime environment and our heritage of dark skies through quality outdoor lighting

Dark Sky Park Designation

Objectives:

A To identify and honor protected public lands (national, state, provincial and other parks and notable public lands) with ***exceptional*** commitment to, and success in implementing, the ideals of dark sky preservation and/or restoration;

B To preserve and/or restore outstanding night skies;

C To promote protection of nocturnal habitat, public enjoyment of the night sky and its heritage, and areas ideal for professional and amateur astronomy;

D To encourage park administrators to identify dark skies as a valuable resource in need of proactive protection;

E To provide international recognition for such parks;

F To encourage parks and similar public entities to become environmental leaders on dark sky issues by communicating the importance of dark skies to the general public and surrounding communities, and by providing an example of what is possible.

Benefits:

Achieving this designation brings recognition of the efforts a park has made towards protecting dark skies. It will raise the awareness of park staff, visitors, and the surrounding community. Designation as an IDA DSP (Dark-Sky Park) entitles the park to display IDA DSP logo in official park publications and promotions, and use of this logo by commercial or other groups within the community when identifying the park area itself (e.g. an organization can say "located in Grand View Park, an IDA DSP" or other words to the same effect). IDA will maintain a web page identifying and describing all DSPs. The park agency may also identify IDA as a park partner.

Eligibility (A-E must each be met):

A All protected public lands, whether managed by national, state, provincial, or local agencies, are eligible. These may include parks, refuges, forests, wilderness areas, monuments, protected rivers, or other categories of protected lands. For this document, they are generically referred to as "parks;"

B Park must provide the opportunity for public nighttime access. A portion of designated land may meet this requirement, or access must be available for a portion of night;

C Park must have an outstanding dark sky resource relative to the population it serves and have locally, regionally, or nationally significant dark sky resources;

D Park night sky must be of minimum quality or better— at a minimum the Milky Way should be visible and sky conditions should approximately correspond to limiting magnitude 5.0 or Bortle Class 6.

E If a park unit is over 50,000 hectare (123,550 acres/193 square miles), a portion of the park may be designated as a Dark Sky Park. This portion must incorporate relevant park developed areas that serve the designated DSP area;

Minimum requirements for all parks (A-E must each be met):

A A quality comprehensive Lighting Guideline or Lightscape Management Plan with the following minimum standards:

1. Fully shielded lights standard throughout the park. When lights are for special purposes or historic preservation compliance, lights under 1000 lumens initial lamp output may be unshielded (non-fully shielded). When such unshielded lights are used, impacts to the lightscape must be addressed, AND;
2. Methods for addressing whether an area should or shouldn't be lit, when an area should or shouldn't be lit, use of guidance lighting, lit signs, tower lighting, and appropriate lighting amount, AND;
3. Methods for addressing what type of lamp (incandescent, fluorescent, high-pressure sodium, etc.) should be used for particular tasks and in particular areas, utilizing appropriate energy efficiency technology and methods for minimizing impact to wildlife, stargazing activities, and nocturnal scenery, AND;
4. Lighting guidelines should conform to or surpass agency or departmental policy on lighting and dark sky protection as well as other applicable guidance and laws (e.g. environmental leadership programs, agency orders, wilderness act, energy management guidelines).

B Park commitment to dark skies and lightscape management, as shown by:

1. Park recognizes dark skies as an important natural, cultural, or scenic resource value as evidenced by inclusion in approved management documents (e.g. General Management Plan, Resource Management Plan, Facility Development Plan), AND
2. Two-thirds (67%) of existing outdoor lighting fixtures conform to the lighting guidelines (or an alternative fraction approved by IDA Board). All lights upon park public lands within the DSP are to be included in this assessment, AND
3. All lighting (100%) on park land (whether operated by park or other entity) conforming, or committed to becoming conforming, with written park lighting guidelines, AND
4. The importance of dark skies/natural darkness and the benefits of good lighting should be part of park interpretation/outreach programs. If park typically provides interpretive programs, then dark skies should be one of the central themes communicated through on-site interpretation. If interpretive programs are not typically offered, then publications, flyers, press releases, media, or other outreach are appropriate substitutes, AND
5. Park has set a leadership example in the restoration of dark skies by implementing one of the following:
    a. Producing at least 1 "night sky friendly" lighting project that is publicly visible and interpreted, OR
    b. Involving at least 2 external partners in dark sky restoration efforts (e.g. chamber of commerce, power utility, university research, tribal nations, environmental groups, conservation groups, natural history association), OR
    c. Cooperation with at least 2 nearby municipalities that results in adoption of lighting codes that improve sky conditions in the park, OR
    d. Inventorying and monitoring night sky quality and using results to educate the public, OR
    e. A combination of a-d above or an alternative restoration project may be suggested.

C IDA may request stricter or alternative requirements in some circumstances.

D Once established, park must erect and maintain a sign indicating Dark Sky Park designation along roadway entrance, along a footpath entrance if no roadway exists, or a visitor contact center. Sign should include IDA DSP text and logo. With IDA Board of Directors approval, an alternative wording may be used, such as Dark Sky Wilderness, Dark Sky Refuge, or similar. The park may include the awarded tier if desired.

E Designation is permanent, but is subject to regular review by IDA and possible revocation if minimum requirements are not maintained.

Sky Quality Tiers:

Once the minimum requirements have been met, a DSP is designated by IDA at one of three levels– Gold, Silver or Bronze indicating the absolute sky quality of the site. *Gold* corresponds to pristine or near-pristine night skies that average close to natural conditions. *Silver* corresponds to nighttime environments that have minor impacts from light pollution and other artificial light disturbance, yet still display good quality night skies and have exemplary nighttime lightscapes. *Bronze* corresponds to areas not meeting the requirements of Silver, yet still offering people, plants and animals a respite from a degraded nocturnal environment. The minimum quality night sky described under Eligibility section D must be met in order to attain Bronze DSP designation. The determination of whether the minimum sky quality standard has been met and what tier will be awarded will be decided by IDA based on submitted information and other available information. Methods for how IDA will determine sky quality tier are found in the Submission Guidelines.

Park Process:

A Nomination by IDA member who has inspected the park, with supporting signatures of a least two additional IDA members from outside the managing agency receiving the nomination;
B Supporting information sent to IDA to demonstrate that the minimum requirements have been met;
C Official letter to IDA supporting nomination from park superintendent or administrator;

IDA Process:

A Once submission packet is received from park, review by IDA to determine if minimum requirements have been met and if stricter or alternative requirements should be imposed;
B Determination of sky quality tier- Gold, Silver or Bronze;
C Approval of nomination by IDA Board of Directors by a majority vote, or denial with reasons and recommendations;
D If approved, awarding of DSP designation and listing on IDA website;
E Periodic checks on DSP to ensure minimum standards are still met, objectives of the program are being upheld, and adequate progress is being made.

Definitions:
Bortle Class- A qualitative method of rating night skies based on visual observations. Developed by John Bortle, the scale ranges from Class 1 (pristine) to Class 9 (strongly light polluted).

Dark Sky Park- A park or other public land possessing notable starry night skies and natural nocturnal habitat where light pollution is mitigated and natural darkness is valuable as an important cultural, scenic, and natural resource. May be part of a larger Dark Sky Preserve, or may not. [Dark Sky Parks are the focus of this document]

Dark Sky Preserve- A large area of high quality dark skies with associated partnerships between protected public lands, municipalities, and private interests that is managed to minimize light pollution. Preserve status is maintained through education, formal agreements, laws, management plans, and/or codes addressing multiple aspects of natural darkness. Such preserves are not presently designated by IDA, but have been established in numerous areas according to a variety of local procedures and standards.

Fully Shielded- A lighting fixture that directs all light downward (below the horizontal) except for incidental reflections from supports or other structures.

Glare- A common condition of natural and artificial lighting caused by excessive contrast between a bright source or brightly lit area and a dark surrounding area. Glare can cause viewers to look away, squint, be annoyed, or compromise their ability to perform vital visual tasks.

Guidance Lighting- Lighting that provides for navigation and safety via very low brightness lamps to mark a path, edge, or roadway instead of the traditional approach of illuminating surfaces.

Illumination- The amount of light falling onto a surface measured in lumens per unit area. The *footcandle* is equal to one lumen per square foot. A *lux* is 1 lumen per square meter, approximately $1/10^{th}$ of a foot-candle.

Interpretation- A communication process, designed to reveal meanings and relationships of our cultural and natural heritage, through involvement with objects, landscapes [or lightscapes], and sites.

Light Pollution- Principally (in this document) the illumination of the night sky caused by artificial light sources, decreasing the visibility of stars and other natural sky phenomena. Also includes other incidental or obtrusive aspects of outdoor lighting such as glare, trespass into areas not needing lighting, use in areas where or at times when lighting is not needed, and disturbance of the natural nighttime landscape.

Lightscape- The total environment created with natural and/or artificial light (here pertaining to the outdoor nocturnal scene).

Limiting Magnitude- The dimmest star that can be seen by the unaided eye. Higher number correspond to fainter stars and thus darker skies. As light pollution increases, contrast is decreased between the background of space and stars, allowing only brighter stars (lower magnitude) to be seen.

Lumen- The unit used to describe the amount of light radiated by a source.

Outreach- Interpretation for the public that takes place outside of the park or prior to their visit.

Guidelines on DSP Process:

Nomination:

The nomination is initiated by an active IDA member who has personally reviewed a park's outdoor lighting and commitment to natural lightscapes. The nomination is a joint effort between park administration and initiating IDA member, and is cosigned by two additional IDA members. Members are encouraged to correspond with IDA DSP designee or IDA Board of Directors throughout this process—from first consideration of a DSP through the final submission package.

The following are typically included in a DSP submission:

1) Map of area to be designated. If area is a portion of a larger park, description of why this portion was chosen
2) Letter of nomination support from appropriate park administrator
3) Management documents supporting dark skies and/or natural lightscapes as a valued resource
4) If it exists, agency or departmental policy on outdoor lighting and dark sky protection
5) Any documentation of sky quality, light pollution measures, satellite pictures, maps, photographs, or other evidence that demonstrates the noteworthiness of the resource
6) Documentation signed by park administrator showing a Lighting Inventory of the park and plan to bring all outdoor lighting into compliance with the Lighting Guidelines
7) Brief description of interpretive program or interpretive products related to dark skies/natural darkness
8) Park Lighting Guidelines
9) Documentation or description of restoration project (e.g. lighting project, community outreach, etc)
10) Proposed alternative wording for DSP (e.g. Dark Sky Wilderness, Dark Sky Refuge, etc), if desired

Approval or Denial:
Approval of a DSP nomination requires a majority vote by IDA Board of Directors. This decision should be made by referencing the submission package, nomination recommendation by IDA member, and other communications regarding the park's suitability as a DSP. The Board should keep in mind that minimum requirements can be made more strict in situations where IDA feels there is inadequate commitment or the park is not meetings its potential. Consider also that the submission package may vary in detail depending on the staff resources at each park. Once approved, the DSP designation should be documented, posted on the website, and suitably announced as soon as practical.

If a nomination is denied, IDA should clearly identify the reasons for rejection and outline what steps should be taken to eventually meet DSP requirements. Partial resubmissions should be allowed at the discretion of IDA.

IDA should designate a panel of IDA members to assist parks with DSP certification, preparing their submission package, and providing recommendations to the Board. IDA should further designate one of the panel members as a point of contact for the program.

Lighting Inventory:
Producing a Lighting Inventory for some parks can be a lengthy task. Therefore, when there are numerous outdoor lights it is acceptable to group lights by facility or area. Whether the fixtures are fully-shielded, are special purpose fixtures under 1000 lumens, and what the lighting application is should be noted for each fixture or group of fixtures. Lighting Inventory should also include a plan or stated commitment to bring all outdoor lights into compliance with the Lighting Guidelines. Daytime photographs or manufacturer diagrams of each fixture type should also accompany the inventory. Contact IDA for clarification or to resolve Lighting Inventory difficulties.

A sample table from portion of a Lighting Inventory:

Location	Fixture(s)	Fully-Shielded	Special Purpose <1000 lumens	Application	Conformity with Lighting Guidelines
Visitor Center	12 fixtures on 14' pole, 70 watt HPS	YES	NO	Parking lot, timer off at 10pm	YES
	2 overhead door lights, 100 watt MH	YES	NO	Building egress	YES
	6 bollard (post) lights, 32 watt compact florescent	NO	NO	Walkway	NO- see plan
Historic Cabin	2 warehouse style lights over doorways, 60watt	NO	YES	Historic Preservation, egress	YES
Maintenance Yard	6 wallpacks, unknown lumens, 250 watt MH	NO	NO	Occasional night operations	NO- see plan
	8 Glarebusters, 13 watt compact fluorescent	YES	NO	Egress, security	YES

Lamps of 1000 lumens output and less include: 60 watt incandescent and less; 60 watt tungsten (quartz) halogen and less; 15 watt fluorescent and less; 13 watt compact fluorescent and less.

Lighting Guidelines:
Park Lighting Guidelines should meet or exceed agency or departmental policies regarding outdoor lighting and should embody good lighting ethics— using light only when it is needed, where it is needed, and in the proper amount. Thus most outdoor lighting fixtures should be fully-shielded and have appropriate use of timers and motion sensors. There should be few instances when this simple guidance is insufficient. Because night sky friendly lighting is inherently efficient, energy use and operational cost reduction goals can be incorporated in this lighting.

The DSP program uses the term "Fully Shielded" as opposed to the more technical term "Full Cut-off." This allows for slightly more variation in fixture type and can be identified without complex photometric reports. It should be clear that "Fully Shielded" defines not only the fixture hardware, but the mounting and installation also. Questions on whether a fixture meets this definition can be relayed to IDA in advance of the submission.

Using the proper amount of light is another important element for good lighting and should be incorporated into Lighting Guidelines. Because of the dark surroundings found in parks, the required illumination levels are often much ***less*** than in urban or residential settings. As with proper shielding and directing of light, the proper amount is important in providing the best visibility, safety, and security. There are several optional methods to constrain lighting levels and illumination:

1) Lighting levels (illumination) may be prescribed within a range of values, typically measured in footcandles or lux. This requires the use of a light meter to verify illumination levels. Without software modeling or extensive lighting experience, it is possible that new lighting installations may produce more or less illumination than necessary, and force an expensive change. This is the most accurate method for controlling illumination levels but requires planning and a certain level of technical ability. This approach is better suited to large developed parks with more sophisticated facility management.
2) Setting a maximum and minimum lamp lumen output for types of fixtures or applications. This gives an approximate method to design illumination levels. Typically, this is done for several categories of fixture (e.g. entryway, walkway, parking lot). This is a simple approach and is suitable for most parks, but it is not as accurate as setting illumination levels (#1 above).
3) Illumination levels can be more accurately designed by integrating mounting height into lumen limits (#2 above). For example, a maximum lumen limit 220x pole height (in meters) squared is a useful guideline: a 6 meter (20') pole would limit to about 8000 lumens; an entry light mounted 2 meters (7') above the ground by a doorway would be limited to 880 lumens. Different multiplication factors may be designated for different applications. Maximum pole heights should also be prescribed under such a system, recommended at 25'. This method adds some complexity but gives tighter control over lighting.
4) Total lumens per acre can be prescribed to developed areas. This prevents negative cumulative effects from too many lights. This method is best used when coupled with method #1, 2, or 3 above.
5) Other methods and specifications for controlling light levels are available from IDA or the Illuminating Engineering Society of North America.

The use of lighting zones, as is done in the IDA Model Lighting Ordinance and several other city codes is a useful tool within a lighting guideline. In parks, these may be a zone of absolutely no lighting (no equivalent in the IDA MLO), zones of minimal light use (Lighting Zone 0 in IDA MLO), and developed high use areas (Lighting Zone 1 in IDA MLO). The use of higher illumination lighting zones is probably not necessary.

While shielded lights typically reduce glare when viewed from the side, there are situations where even fully-shielded lights may cause an unacceptable impact. One example is when the light is elevated over surrounding terrain, perhaps on a mesa, hilltop, water tank, or similar structure. The glare from these lights can be viewed from many kilometers away and potentially pose a negative impact to wildland values, cultural landscapes, wilderness, and wildlife. This issue should be included in the Lighting Guidelines if it is germane to the park

Protecting wildlife and nocturnal habitat often requires greater consideration and constraints than lighting to protect night sky visibility. Most parks will have ecological issues that need addressing in Lighting Guidelines. The best approach may require consultation with wildlife experts, but a few methods are listed here for consideration:

1) Designation of wildlife corridors, buffer areas around streams, shorelines, or other ecological important edges where lighting is not allowed or is permitted only when fully shielded at very low brightness.
2) Use of narrow spectrum lighting that avoids impact to certain species. This proper color of light will vary from species to species and habitat to habitat. Yellow incandescent lamps ("bug" lights) and low-pressure sodium lighting (LPS) are frequently good choices, but not always.
3) Turn off lights with timers or motion sensors to minimize duration of impact. Omit lighting during certain periods of the year that are known to be critical to wildlife (e.g. bird migration periods).
4) Use of only strobe lights (quick flashing lights that dim completely between cycles) for buoys, towers, and markers to minimize bird disorientation.

Requirements for the DSP allow for the use of 1000 lumen unshielded lights for special purposes. This provision is to allow for the use of historic lights or lighting required by historical preservation mandates, guidance lighting, or other unique requirements. The approved special uses should be stated in the lighting guideline. IDA will scrutinize these uses to ensure that park lighting is a suitable example of good lighting for the public and protects the nighttime environment to the maximum practical extent. IDA may request additional descriptions, photographs, or drawings of these lights. These lights are not exempt from the lighting guidelines, and must still be designed to minimize impact to the lightscape.

While outdoor lights are used mostly for safety purposes, a park may incorporate lights that have other uses. Examples include lit signs, flags, vending machines, building façades, statues and plaques. Though these are not forbidden in Dark Sky Parks, the Lighting Guidelines must provide constraints on these types of generally non-essential lighting. Such lighting should have lamp lumen or illumination limits, timing limits, and be shielded if possible. IDA will scrutinize this section of the lighting guidelines to ensure the park provides a good leadership example to the public.

Finally, each lighting application should be examined for appropriateness, timing and duty cycle, and energy efficiency. For example, it is expected that the Lighting Guidelines would designate areas that should have no permanent lighting. Other types of lighting such as infrequently used buildings should have motion sensor security lights. Such limitations are important in lowering the overall impact of artificial lighting, especially considering solar power lighting is now viable in remote locations.

Sky Quality Tier Determination:

A variety of indicators are used to determine absolute sky quality at the Gold, Silver, or Bronze tier. The lower end of the Bronze tier coincides with the minimum sky quality requirement for DSP designation. This objective decision is made based on many factors, with no one factor being the key decider. Indicators may conflict because of differences in geography, climate, seasonality, view of horizon, elevation, or other factors. No single indicator should force a tier determination. For example, an area may be awarded Silver despite only having limiting magnitude 5.8 if the majority of other factors support the Silver designation. In many cases, full information may not be available and the process must proceed with only readily available information.

Within a proposed DSP boundary there will be a range of sky conditions, which presents a challenging situation from which to make an assessment. In general, the lightscape condition where night visitation and interpretation should be assessed, but IDA may require additional areas to be assessed.

It should be made clear that the expectations of a DSP to promote dark skies and natural lightscapes are equal among designees, regardless of their tier status– Gold, Silver, or Bronze.

The following table provides guidance to IDA in determining tier:

Indicator	Gold	Silver	Bronze
Philosophy	Nighttime environments that have negligible to minor impacts from light pollution and other artificial light disturbance, yet still display outstanding quality night skies and have superior nighttime lightscapes.	Nighttime environments that have minor impacts from light pollution and other artificial light disturbance, yet still display good quality night skies and have exemplary nighttime lightscapes.	Areas not meeting the requirements of *Silver*, yet still offering people, plants and animals a respite from a degraded nocturnal environment and suitable for communicating the issue of light pollution and connecting people with the many aspects of the night sky.
Artificial Light and Skyglow	Typical observer is not distracted by glary light sources. Light domes are only dim and restricted to sky close to horizon.	Point light sources and glary lights do not dominate nighttime scene. Light domes present around horizon but do not stretch to zenith.	Areas with greater artificial light and skyglow than *Silver*, but where aspects of the natural sky are still visible.
Visual Limiting Magnitude	Equal or greater than 6.8 under clear skies and good seeing conditions	6.0 to 6.7 under clear skies and good conditions	5.0-5.9 under clear skies and good seeing conditions
Bortle Sky Class	1-3	3-5	5-6
International Astronomical Union Definition	Unpolluted sky, less than 10% artificial light increase at 45° altitude	Light Polluted Sky (minor to moderate)	Light Polluted Sky (moderate)
Schaaf Class	7+	4-7	3-4
Observable Sky Phenomena	The full array of visible sky phenomena can be viewed—e.g. aurora, airglow, Milky Way, zodiacal light, and faint meteors.	Brighter sky phenomena can be regularly viewed, with fainter ones sometimes visible. Milky Way is visible in summer and winter.	Many sky phenomena cannot be seen. Milky Way is faintly seen when pointed out to the average person, as is the Andromeda Galaxy.
Nocturnal Environment	Area is devoid of obvious lights that can cause wildlife disorientation. Artificial light levels are thought to be below the threshold for plant and animal impact. Ecological processes related to nocturnality are unaltered. No lighting atop towers or buildings within park boundary.	Areas that have minor to moderate ground illumination from artificial skyglow. Lights that may cause disorientation to wildlife are distant. Disruption of ecological processes is minor with no impairment to plants or wildlife.	Areas with greater nocturnal impact than *Silver*, but where photo-based ecosystem processes are still functional.
Cinzano et. al .2001 Sky Brightness Model	< 0.11 artificial light contribution at zenith (as a fraction of natural background)	0.11-3.0 artificial light contribution at zenith (as a fraction of natural background)	3.0-9.0 artificial light contribution at zenith (as a fraction of natural background)
NPS Method Total Sky Brightness Above 20° Alt.	Pending- propose –6.75	Pending- propose –8.00	*Pending- propose –10.00*
Unihedron Sky Quality Meter	*Pending- propose 21.75*	Pending- propose 21.00	*Pending- propose 20.00*

Further information on the Bortle Dark-sky Scale can be found at:
http://skyandtelescope.com/resources/darksky/article_81_1.asp
Further information on the Schaaf Scale can be found at:
http://laps.noaa.gov/albers/lp/gwpaper/lppaper.htm
Further information on Sky Brightness Model by Cinzano et. Al. can be found at:
http://www.inquinamentoluminoso.it/dmsp/
A few references on Visual Limiting Magnitude can be found at:
http://www.imo.net/visual/major/observation/lm
http://www.phys-astro.sonoma.edu/observatory/observers/limiting_magnitude.html
The George Wright Forum, published by the George Wright Society, Hancock, Michigan, USA, 18:4, 2004.

Note: According to Cinzano et Al. 2001, 1% of US population lives in gold areas, 16% in silver, and 21% in bronze. Compare that to Australia at 29%, 9%, and 25% or Canada at 3%, 14%, and 12% or Germany 0%, 34% and 41%. Thus Gold DSPs will likely be designated in areas of sparse population, but may vary from country to country.

Reassessment of DSP Designations:
To assure that DSPs continue to be exemplary in their protection and restoration of natural lightscapes, IDA will periodically re-assess DSPs. This will assure that parks continue to meet the minimum requirements, are sustaining partnership and interpretation efforts, and are making adequate progress toward 100% compliance with lighting guidelines. It is expected that a simple assessment will be made at approximately 5-year intervals, relying upon conversations with park management, on site checks by the original nominating member, or other creative and low cost means to ascertain the park's commitment to the DSP designation. If questions or concerns remain after this cursory review, it may then be necessary for IDA make additional efforts and/or the DSP to submit evidence defending their status.

DSP Program Review:
It is recommended that the DSP program be reviewed 2 years from initial approval and at 5-year intervals thereafter. This will keep documentation current, provide clarification of common questions, close loopholes, and keep the program responsive to evolving public attitudes, technology, and scientific understanding. It will also be important to compare this document with other competing certifications that may arise. Other suggested considerations include: application and acceptance rate, balancing participation in the program with the prestige it bestows, open submission vs. call for applications, target participation rates at each tier, reassessment processes, and workload.

Contributors:

Development Committee:
Chris Luginbuhl- US Naval Observatory, IDA Board Member
Ralph Jones- US National Park Service
Angela Richman- Astronomy Education Consultant
Chad Moore- US National Park Service

Review Committee:
Chloé Legris- Project manager, ASTROLab of Mont-Mégantic
Steve Cary- New Mexico State Parks
Scott Davis- International Dark-Sky Association
David Welch- Parks Canada
Brad Shattuck- US National Park Service
Lazlo Lazowska- New Mexico Heritage Preservation Alliance
Dan Duriscoe- US National Park Service
Catherine Rich- The Urban Wildlands Group
John Gilkison- National Public Observatory
Chip Harrison- Cherry Springs State Park
Martin Aube- Groupe de Recherche et d'Applications en Physique au College de Sherbrooke (GRAPHYCS)

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IDA Park Nomination Review Panel:
Chris Luginbuhl- US Naval Observatory, IDA Board Member
Angela Richman- Astronomy Education Consultant
Chad Moore- US National Park Service

Approval:
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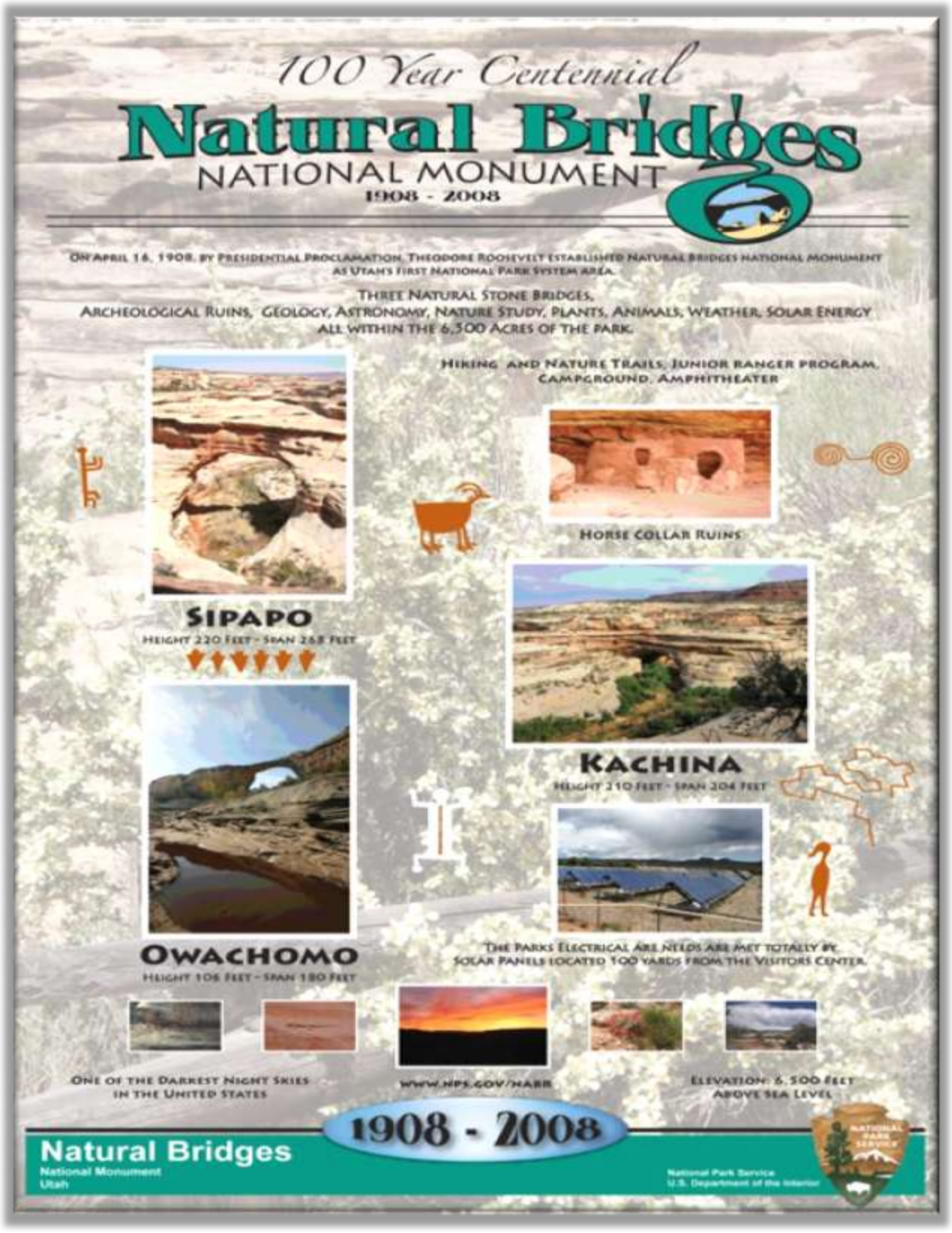
Revised:
V. 1.3 IDA edits completed, March 23, 2006
V. 1.31 Draft tier recommendation for Sky Quality Meter and NPS Method
V. 1.31 Minor addition to DSP Program Review



Nomination Prepared By:

Ralph Jones, Chief Ranger
Natural Bridges & Hovenweep National Monuments
HC 60 Box 1, Lake Powell UT, 84533
Phone: 435-692-1234 x13, Fax: 435-692-1111
ralph_jones@nps.gov

Chad Moore, NPS Night Sky Team
Bryce Canyon National Park
PO Box 64020, Bryce Canyon, UT 84764
435-834-4904
chad_moore@nps.gov